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TESTING OF LUBRICATING OILS

Some Valuable Methods of Determining the Specific Gravity, Viscosity, Acidity and Alkalinity

BY W. H. JENKINS, PH. B.

When the practical or non-technical engineer is approached regarding the testing of lubricating oils, he rarely understands what is meant. He thinks it is beyond him and should be confined to the chemist; this latter is true, if absolutely accurate results are desired, but if the objects of these various tests were clearly understood, the testing would not seem such an impossibility.

The results obtained would be approximately correct and they would give, if conducted under similar conditions, good, comparative results.

The requirements of a good lubricant are as follows:

1. It should be as fluid as possible consistent with body.
2. It should have body enough which will prevent the surfaces to which it is applied from coming in contact with each other.
3. It should be free from alkalies and corrosive acids.
4. It should be free from such constituents which are liable to cause gumming.
5. It should have a minimum coefficient of friction and high flash and burning points.

The practical engineer is, of course, not expected to perform tests verifying all these requirements unless he understands each test and possesses the required apparatus, but he can, however, make some tests with home-made apparatus which will give approximate results. These tests would include (1) the determination as to whether the oil was a simple mineral, vegetable or animal oil, or a mixture of these; (2) the specific gravity; (3) vicosity, and (4) the presence of alkalies.

Lubricating oils may be mineral oil, vegetable oil, animal oil or a mixture of two or more of these. Not all users of lubricants appreciate the real value of a mineral lubricating oil in comparison with the various vegetable and animal oils. Mineral oils are used on all kinds of machinery; they are the safest and cheapest and generally superior to vegetable and animal oils, although the oils usually termed "compound" oils, which are mixtures of mineral oil and vegetable and animal oils, are becoming the principal lubricants for certain purposes. Mineral oils are more desirable, because they are usually not affected by high pressure steam or alkalies; they are free from acid, and neither gum nor become rancid. High pressure steam decomposes animal and vegetable oils, yielding a fatty acid as one of the products, and which readily attacks most metals and their alloys.

Mineral oils possess a property, termed fluorescence, which vegetable and animal oils do not possess and is of considerable value in determining the presence of a mineral oil. Fluorescence is the yellowish-green color that is observed when a surface of glass is wetted with a mineral oil and then held at such an angle that the light will properly reflect it. It can easily be observed in kerosene oil.

When examining for fluorescence, it should be remembered that this property is perceptible only in daylight, or in an artificial white light; further, if the oil is turbid, it should be filtered before applying the test, as the minute floating particles in the oil reflect light in such a manner that this reflected light is liable to be mistaken for fluorescence. If the oil is of an extremely dark color, it is difficult to observe this property, but a trained eye can usually detect it. If fluorescence is indicated, the sample undoubtedly contains some mineral oil, although, if it is not indicated, the absence of this property does not prove the absence of mineral, because the fluorescence of some varieties of mineral oil can be destroyed by certain treatments, but the mineral oils mostly used as lubricants possess fluorescence to a very marked degree.

To determine fluorescence, several simple methods may be employed: (1) Holding a test-tube or long narrow bottle filled with the oil in a vertical position in front of a window and looking at the side from above; (2) lay a glass rod, previously dipped in the oil, on a table or bench in front of a window, so that the oily end of the rod shall extend over the end or edge of table or bench; (3) make a thick streak of oil on a piece of black marble or glass plate smoked at the back and place the streaked surface in a horizontal position at right angles and in front of a lighted window.

Vegetable and Animal Oils. The presence of vegetable or animal oils can be positively determined by what is termed the saponification test; or in other words, the transformation of the vegetable or animal oil into soaps by the treatment with an alkali. To perform this test, there will be required an 8-ounce (½-pint) bottle, colorless glass preferred, some light

gasoline or benzine, dilute sulphuric acid, blue and red litmus paper, and an alcoholic solution of an alkali (potash lye). All of these can be purchased at any drug store.

To perform the test, place 2 to 4 tablespoonsful of the oil in the 8-ounce bottle and add 5 tablespoonsful of the potash lye solution. Shake and place the bottle loosely corked in boiling water, or on a steam pipe or radiator, or anywhere where the heat is sufficient to gradually drive off the alcohol. During this process, the animal or vegetable oil is formed into soap by the potash lye, while the mineral oil remains unaffected. Five tablespoonsful of water are now added and the whole shaken so as to bring the soap into solution in the water. When this has been accomplished, 5 tablespoonsful of gasoline or benzine are added, stoppered, well-shaken, and set aside for twelve hours. At the end of this time the mixture will have separated into two distinct layers or liquids, the lower layers consisting of the water containing the soap in solution and the upper layer of gasoline containing the mineral oil in solution. The upper layer will be colored if mineral oil is present. The bottle is now inverted and the soap solution drawn off into a small glass or porcelain dish, to which is then added sufficient of the dilute sulphuric acid to change the color of the blue litmus paper red. The sulphuric acid decomposes the soap, and vegetable or animal oil is indicated by the fatty acids (originally contained in the oil and saponified by the potash lye) rising to the surface of the liquid. If the solution be sufficiently

Fig. 1

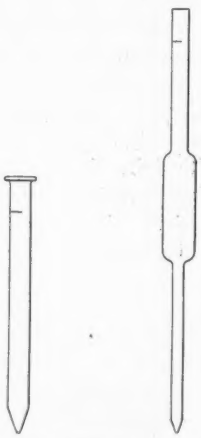


Fig. 2

cooled, the fatty acids can be removed similar to a cake of wax. The presence of fatty acids is absolute proof of animal or vegetable oil. To confirm the presence of mineral oil, some of the gasoline or benzine solution is placed in a vessel of glass or porcelain and placed on a radiator when the benzine or gasoline will be driven off, leaving the mineral oil in the vessel.

Specific Gravity.—Specific gravity is the relative weight of the same volume of a liquid at the same temperature when compared to that of some liquid chosen as a standard. For liquids, water is the standard. To determine this value, a small flask is necessary, the volume of which is known, the height for the given volume being marked on the flask with a file. The flask is first filled to the mark with water and weighed. It is then dried and filled to the mark with the oil and again weighed. The weight of the oil divided by the weight of the same volume of water gives the specific gravity of the oil. Example: Weight of bottle and water is 5¼ ounces, weight of bottle and oil is 5 ounces; hence $5 \div 5\frac{1}{4} = 0.952$ specific gravity of oil.

A more convenient method for determining the specific gravity is by means of a hydrometer shown in Fig. 1. A vessel of glass taller than the length of the hydrometer is almost filled with the oil and allowed to come to the room temperature. The hydrometer is then floated in the oil and the specific gravity can be read directly on the graduated stem.

Viscosity.—Viscosity is the relative fluidity or body of the fluid. The general method of determining this value is by means of the viscosimeter, but an approximate value can be obtained as follows: A glass cylinder, as shown in Fig. 2, open at the top and drawn to 1/32 of an inch at the bottom, is used and the volume of the cylinder up to a certain height is determined and marked with a file. The cylinder is then filled to the mark with water and the exact time for this quantity to flow out is noted. This is taken as the standard and has the value of one. This value need be taken but once, unless there are large differences of temperature in the room. The cylinder is then filled to the mark with oil and the time required for the oil to flow out is noted. *Example.* Capacity of cylinder is 5 tablespoonsful; this amount of water flowed out in 5¼ minutes and the same quantity of oil required six minutes. It is evident from this that the oil has a greater body than the water, hence $5\frac{1}{4} \div 6 = .875$, the viscosity of the oil.

In all determinations, the temperature of the water and oil should be the same. As most lubricating oils are quite viscid or thick, it is usually necessary to determine the viscosity value at a higher temperature than the room temperature. The temperature at which it is usually taken is 100° F. The apparatus made especialy for determining the viscosity value is made on the same principle as an oil-cup, and, in fact, an approximate value may be determined with a calibrated oil-cup.

Acidity or *Alkalinity.*—Alkalies are frequently used in the refining of some vegetable and animal oils and acids are used in the refining of mineral oils. If these have not been eliminated in the further process of refining, they will be present in the finished product and will attack the bearings. Quite frequently, also, vegetable and animal oils decompose to a certain degree, liberating free, fatty acids, the presence of which is also objectionable.

To determine their presence, a solution known as an indicator is required. This is prepared by dissolving one part of methyl-orange in 1,000 parts of water, or 15 grains to one quart of water. Methyl-orange can be purchased at most first-class drug-stores. Four or five tablespoonsful of the oil are shaken in a bottle with an equal volume of tepid water, to which a few drops of methyl-orange has been added. Set it aside to separate, and if acid is present, the water will be colored red; if alkali is present, it will be colored yellow.

If considerable acid or alkali is present, they can be determined by using blue or red litmus paper, instead of the methyl-orange solution. After shaking the oil with plain tepid water, allow to separate, draw off and dip a piece of litmus paper into the water. If the blue litmus paper is changed to red, acid is indicated, but if the red litmus paper is changed to blue, alkali is indicated.

REMEDIES FOR MOTOR TROUBLES

Practical Things the Engineer Should Know About Electrically Operated Plants

By Wm. Kavanagh.

When taking charge of an electrically-driven plant the engineer, who is not versed in the practical details of motors, wiring, starting rheostats, etc., will encounter numerous problems that he never imagined existed, and it will be to the interest of such an engineer to read carefully the following hints, as they will be found very useful in practice.

In general electrically driven power plants are equipped either with the unit motor drive, or motor shaft drive. In the unit motor drive each machine is driven by an individual motor, while with the motor shaft drive one or two motors may run two or more lines of shafting, the machines requiring power being belted to this shafting. The greatest number of accidents occur when the individual motor drive is used, as the operators having charge of the machines do the starting and stopping of the motors to suit themselves, and, as a rule, have not the slightest knowledge of motors or their operation. This frequently results in the breaking down of some part of the electrical equipment.

Another difficulty met with in practice is the burning-out of the motor-starting rheostat, and, of course, when this occurs, the engineer is called upon to make repairs or get the motor running. When the starting rheostat fails the engineer should take with him a test lamp and test out the starting rheostat in order to locate the burned-out coils, which usually result from such an accident. When the burned-out coil is located temporary repairs may be made by "jumping" the burned-out coil, and thus permitting the current to flow through the rheostat, which would otherwise be impossible, because of that coil. Fig. 1 shows a rheostat in which a jumper has been used, the jumper being shown at A. To locate the burned-out coil, connect the test lamp to some convenient socket and test out each coil as shown at C and D in Fig. 1. The lamp will light every time a good coil is tested, but when the burned-out coil is reached the lamp will remain unlighted. After locating the injured coil it may be jumped by soldering or connecting a piece of wire, as shown at A, Fig. 1, and the manner in which the jumper is placed shows the injured coil B, cut out. However, this method of repair is only temporarily employed when time will not permit the insertion of a new coil or the making of permanent repairs.

The bearings of motors are not made adjustable, and on account of this, the bearings must be renewed whenever necessary, as the wear cannot be taken up. These bearings will be found to wear in the direction of the strain imposed upon them and consequently this strain may be at any angle. To determine the direction of wear, the engineer in charge of the motors should obtain a few strips of sheet brass of varying thickness and of about ⅜ of an inch in width. By passing one of these strips between the armature and pole pieces the direction of wear may be easily determined. The distance of the armature from the poles is called the clearance and this distance should be maintained equally between the armature and the poles. In testing for clearance the thickest strip should be used first, and if it is found that this thickness is too great to pass through, then the next thickest strip should be used, and so on. In this way the pole nearest the armature will show the direction of wear and the thickness of the strip used will give the engineer some idea of how long the bearing will last.

When the bearings become worn the hole in which the armature shaft rotates will be oblong in shape instead of circular, and the thinnest part of the bearing will be in the direction of the pull of the belt. This is true in respect to the pulley-bearing, while the reverse is true in respect to the armature-bearing. Fig. 2 shows how the armature has approached the lowest pole piece, the strain of the belt in this case being downward. As soon as the testing strip indicates the lowering of an armature, a careful watch must be kept on that particular armature to prevent the horns of the poles from striking against the binding bands, which are wound around the armature to prevent the coils from being thrown out of their slots. Sometimes the horns of the poles are sharp and should

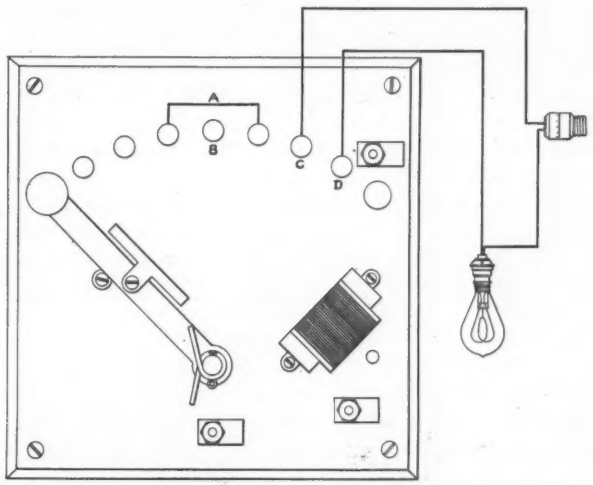


Fig. 1

the armature lower sufficiently, these sharp edges will cut the binding bands off, necessitating the removal of the armature in order to place new binding wire over the coils. Such an accident as the loss of the binding bands shuts down that particular machine or line of shafting, which the motor drives, and the replacing of new binding bands involves much labor, especially if the armature is large. When the thinnest testing strip cannot be passed between any pole and the armature, new bearings should be inserted and a stock of bearings should always be kept on hand for this purpose.

Another frequent source of trouble with motors is the non-rotation of the oiling rings. The failing of these rings to rotate cause hot bearings, and, as in the majority of motors, the bearings are made of babbitt metal, the weight of the armature in connection with the strain of the belt crushes the softened metal, resulting in the loss of the binding bands and probably

one or more armature coils. Thus it may be seen how important it is to have the oiling rings rotate freely. These rings stop rotating when they become oblong, or worn out of true, which is caused by their failing to start when the journal begins rotating. In this way a small arc is worn inside the ring, which permits it to balance, or swing like a pendulum on the journal. Non-rotation is also caused by burrs in the slit of the bearing, and the use of gummy oil in the oil wells. If the oil well leaks, hot bearings will also result and sometimes the speed of the rings is so great that the oil will be thrown out of the well, reducing the depth of the oil to a dangerous degree. Fig. 3 is an end view of two bearings from the same motor, showing the manner in which they wore. A is the pulley-bearing, and the strain of the belt caused the bearing to wear as indicated by the arrow, while B is the armature-bearing, and the wear is directly opposite to that in A. Fig. 4 shows an oiling ring with an arc worn in its inner circumference, corresponding to the circumference of the journal. This arc, shown at B, prevents rotation of the ring, especially if the oil in the well is thick or gummy. A very good plan to follow in attending to the oiling of motors is to change the oil at least once every two weeks. However, the number of times the oil should be changed depends on the conditions under which the motor operates. If the motor is running in a gritty atmosphere the oil should be changed oftener, and if the oil wells are washed out with kerosene it will be found to be a great advantage in keeping the bearings cool.

The opening of the circuit breaker is another difficulty often experienced in the electrically-driven plant. When the circuit breaker opens it is good practice to open all the power switches before closing the circuit breaker. The reason for doing this is easily understood; if the power switches are permitted to remain closed when the circuit breaker is thrown in, the line or circuit on which the trouble lies, cannot be quickly found. If, on the other hand, all of the power switches are open the moment the circuit breaker is closed, then, as each switch is

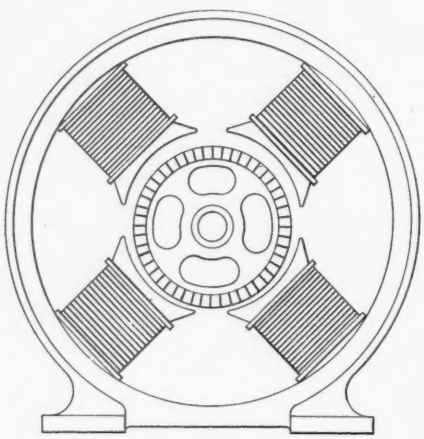


Fig. 2

connected to its circuit the trouble will be discovered on some particular line; and the engineer will be able to direct his assistant or electrician to that line.

Another difficulty which may be encountered is the burning-out of the dynamo field rheostat, and this will close down the whole plant, unless there are other units to place in operation. The dynamo having such an accident happen to it may be placed in operation by the constructing of a water rheostat. To construct and connect a water rheostat, fill a barrel with water and place it near the switchboard, then disconnect the wire leading from the dynamo field to the rheostat and connect to this wire a piece of sheet copper, and drop the wire and copper-plate into the barrel; the plate should rest on the bottom of the barrel. Connect another copper plate to the wire leading from the rheostat to the bus-bar and lower this plate into the water. The resistance may be increased or decreased by the raising or lowering of this plate, thus enabling the plant to be placed in operation. When this rheostat is to

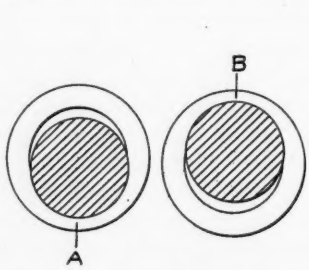


Fig. 3

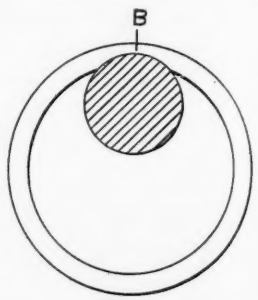


Fig. 4

remain attached for any considerable length of time a pulley may be arranged so as to enable the raising or lowering of the plate without difficulty. If the resistance of the water is too great, the adding of common table salt will increase the conductivity of the water. When copper plates are not at hand to attach to the rheostat wires, a bundle of copper wire will answer the same purpose. One thing that should be carefully observed in using the water rheostat, is the wires leading to the plates in the barrel. These wires waste away rapidly, and a close watch should be kept on the movable wire lest it should become weakened and drop the plate, and, by so doing, this wire will in all probability leave the water and thus close down the plant.

Whenever a bare wire carrying current comes in contact with the earth a ground is formed, and modern switch-boards are usually equipped with a ground detector for detecting this.

Assuming the detector is of the voltmeter type and indicates a ground of 80 volts, it is only necessary to pull the switches on the board until the ground disappears to locate the grounded circuit. After locating the grounded circuit the ground may then be located by pulling the switches or by turning off or on various branches that may lead from the grounded circuit.

The remedies for motor troubles in this article are based on practical experience, and should prove instructive as well as interesting to many engineers, and will be found especially valuable to those who are about to change from the old-time steam plant to the more modern one, operated by electricity.

The causes of incrustation in a boiler may be due to the deposition of suspended matter; the deposition of dissolved salts from concentration; the deposition of carbonates of lime and magnesia by boiling off carbonic acid, which holds them in solution; deposition of sulphate of lime, which is insoluble in hot water; deposition of magnesia, because magnesium salts decompose at high temperature; and deposition formed by the saponification of grease.

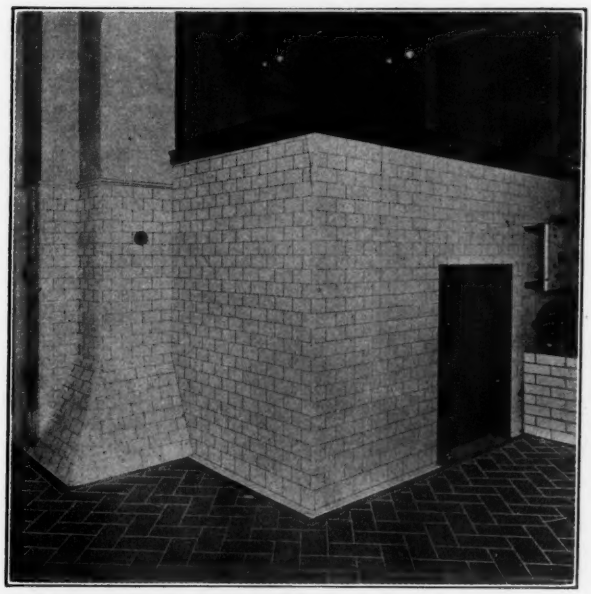
THE TILED ENGINE ROOM

By C. J. Fox, Ph. D.

Tiling is now quite generally used as a covering for the floors and walls of engine rooms. Its advantages are numerous and should be realized by architects, builders and others, who may be interested in the erection of modern up-to-date power plants of any description.

Tiling properly set in hard cement is durable, fireproof, non-absorbent and easy to keep clean and neat looking. It is made of clay, baked so that it becomes harder than any natural stone or even cement, and being non-porous it cannot absorb moisture, dirt or any other foreign substances which so frequently disintegrate the walls and floors of less substantial material. Even a sharp steel blade cannot scratch a vitrified tile any more than the ordinary knife scratches a dinner plate. In flooring materials this fact is of great importance, because the most destructive agent of all floors is the hard steel nails of the shoe, which soon wear deep indentations into marble, granite, slate and other flooring materials in common use.

With particular reference to the engine-room, one of the specific values of tiling the floors and walls is that it cannot absorb the lubricating oil, grease and other similar materials that are necessarily dropped upon the floor, or spattered upon the walls by the revolving crank shafts. Wood, of course, readily absorbs this oil or grease, which causes it to emit a more or less disagreeable odor, and furthermore renders it highly inflammable. This last condition is all the more dangerous because of the necessary proximity of fire which in many instances within the past few years has destroyed many large

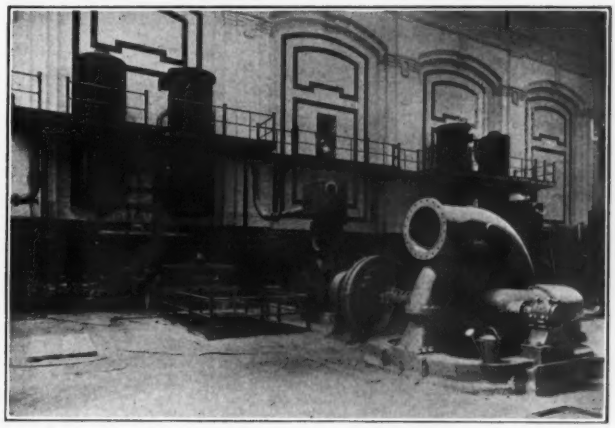


Tiled Engine Room, Hotel Astor, New York

power plants which would have been standing to-day had the walls and floors been made of an inorganic material.

The modern machinery of the engine room is usually a model of mechanical perfection. Among the important duties of the engineer is to see that this machinery is kept in first-class condition, and, above all, scrupulously clean. One of the greatest aids in doing this is to have the machinery housed in a room, the floors and walls of which can be easily kept spotless. Cement, for instance, although one of the greatest of modern building materials, does not make a good floor or wall covering, because it is more or less porous, wears rough and the countless small crevices on its surface become clogged with foreign material and filth of all kinds, which is virtually impossible to remove.

The decorative and artistic properties of tiling, although



Tiling in the Edison Power Station, S. Boston, Mass.

not so essential in an engine room as in other places, are nevertheless of considerable importance. There is something of magnificent dignity about gigantic modern machinery, and it should be housed in a room, the attractive appearance of which is commensurate with this dignity. Furthermore, the moral effect of attractive-looking floors and walls should not be under-estimated. An attractive-appearing room offers a strong inducement to the men in charge of the machinery to live up to the appearance of their surroundings, and keep their engines in the same immaculate condition, as far as cleanliness is concerned, as is the room in which they work.

These numerous considerations have been taken into account by many builders of high class power plants, who now realize that the slight increase in the initial expense of the tiling of the floors and walls of the engine room is in the end a permanent economy and a wise investment.

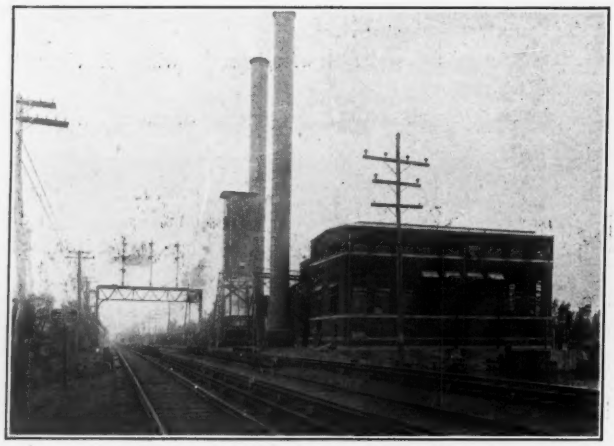
San Francisco Power Plant to be Earthquakeproof.

One of most distinctive of the numerous fireproof structures now in process of erection in San Francisco is the power station being built for the City Electric Co. Requirements for the structure are that it shall be, in so far as is practical, earthquakeproof. The foundation is placed on piles driven to hard pan 50 feet below the street level and the unit stresses, both in the concrete and steel, are made well within the usual requirements. The reinforced concrete structure is planned to furnish space for two 2,000 kilowatt turbines, with four batteries of water tube boilers, and will furnish light, heat and power for various commercial purposes.

Electrification of the West Jersey and Seashore Railroad

Pennsylvania Railroad Power House at Westville, N. J.

When the application of electricity to steam railroads was first considered, it was at once seen that if any road in this country adopted the electric power in place of the puffing locomotive, it would be the Pennsylvania railroad. Among all the many business men of that city travel to and fro every day, as if it were a suburb. Consequently, the ride must be short, the trains frequent and conditions cleanly. The electrification of the road has met these conditions. A speed of 60 miles an



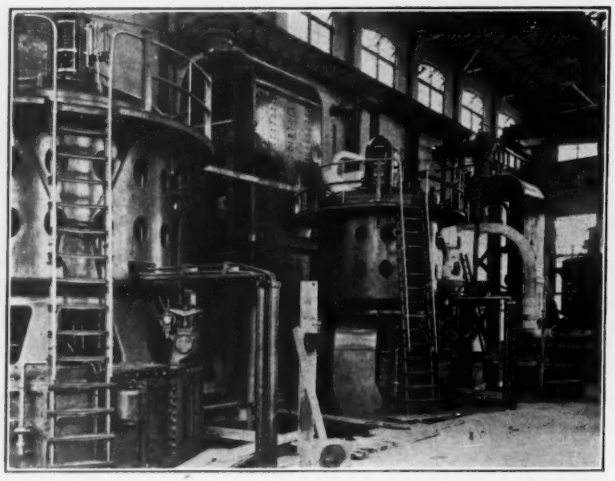
Power House at Westville, N. J.

Transformers, Lightning Arresters and Rotary Converter at Westville Power House

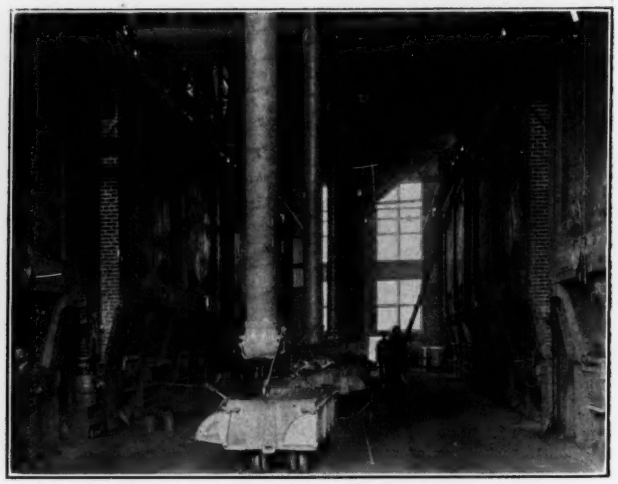
various conditions which this railroad had to meet, the ideal condition for electrification presented itself on the line running between Camden, N. J., and Atlantic City. The Pennsylvania railroad own two roads between Camden and Atlantic City, and it was decided to equip one of these roads for electric propulsion. The road selected is known as the West Jersey and Seashore Railroad, and extends from Camden via Newfield to Atlantic City, a distance of 65 miles.

The principal reasons why conditions are so ideal for electrification on this road are because the road is practically straight and level and enormous crowds must be carried between Camden and Atlantic City at certain times of the day during certain portions of the year. On some hot days in summer, Philadelphia alone sends some 75,000 pleasure-seekers to the shore, and hour is attained by the express trains and the distance of 65 miles at the present time is traversed in one and one-half hours. A local service is also maintained between the towns near the Camden end of the line.

To equip the road for its new motive power, 150 miles of track was supplied with a third rail in the country and trolley wire in the cities at the terminals, a power house was built at Westville, seven substations were built along the line and 71 miles of duplicate high tension transmission lines were erected.



2000 K.W. 7200 Volt Turbo-Generators in the Westville Power House



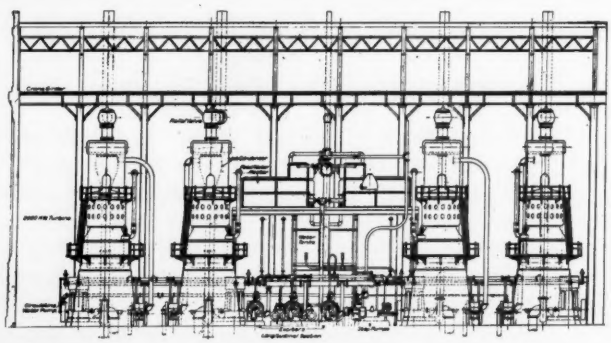
Boiler Room, Westville Power House

The method of distribution includes the generation of 7200-volt, 27.5 cycle current at the power house, which is transformed to 36,000 volts for line transmission. At each of the substations the 36,000-volt alternating current is converted into

650-volt direct current, which is applied to the various sections of the road for traction purposes.

The power house is located on a large creek at Westville, N. J., about 5½ miles from Camden, so that both fuel and water can be supplied in abundance. The power house is substantially built of red brick, the boiler-room being divided from the generator-room by a heavy brick wall. Both the boiler and generator rooms are particularly high, light and airy. One end of the building contains a temporary partition, so that the building can be extended along the line of the creek when necessary.

The boiler-room contains twelve Stirling water-tube boilers, arranged in pairs, forming six batteries. Each boiler has a rated capacity of 358 horse power when supplying steam at 175 pounds pressure and a superheat of 125 degrees. Bituminous coal is used for fuel, which is dumped from the railway cars into a receiving hopper at ground level. The receiving hopper has a slanting bottom, at the end of which there is a valve, which is opened only when the car, which is placed under it, is in the correct loading position about 20 feet below the ground level. When the car is full, a hoisting engine raises it considerably higher than the roof of the power house and it is automatically tipped into a crushing hopper, the smaller coal passing through a screen and the larger pieces crushed before it reaches the hopper below. From this hopper



Longitudinal Section through Turbine Room

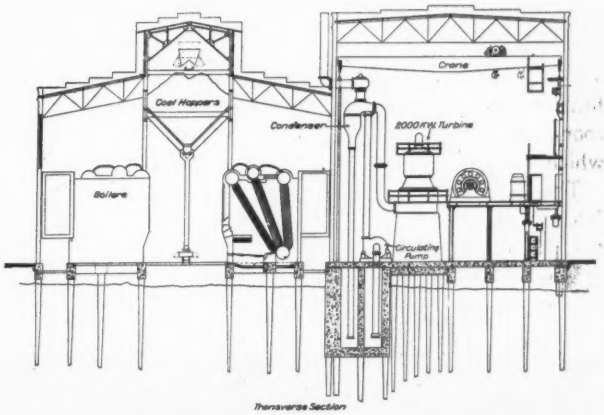
the coal is fed into a car, which runs on a 5 per cent. grade to the bunkers overhead the boiler-room. The car and tipping device are so arranged that when the car has emptied its load, a triangular weight against which the car rests is sufficient to drive the car back up the grade by its recoil. From the coal hoppers the coal is fed by means of chutes to coal cars, which run on tracks on the boiler-room floor. The coal is hand fired and the ashes are taken from the boiler-room in cars and dumped into a receiving hopper, from which they are raised to a storage bin, and by means of a chute to cars on the railway track.

The boilers are supplied with water from the tail race of the condensers. Two make-up pumps, 9" x 12" x 10", Worthington type, pump the water from the tail race to two tanks located about 20 feet above the engine-room floor and 10 feet below the feed water heaters. Three boiler feed pumps of the Worthington outside packed type, 17" x 10" x 15", pump the water through two 10,000 horse power Cochrane heaters into the boilers. Two of these pumps are equipped with Fischer pump regulators and the third with a Berry pump regulator. The boilers supply steam at 175 pounds pressure and 125 degrees superheat, to a header which allows of supplying the steam to the turbines in unit fashion or in multiple.

The present equipment of the generating room consists of three 2,000 Kilowatt, 7,200-volt, 27.5 cycle, three-phase, four-stage Curtis turbo-generators. For exciting units, three 75 kilowatt, two-stage, horizontal turbine units, are employed, running 2,400 revolutions per minute and supplying 125 volts direct current.

Each turbo-generator unit is equipped with a Williamson barometric condenser, dry vacuum pump, wet vacuum pump and centrifugal supply pump. The condensing water is pumped from a supply conduit under the engine-room floor to the atmospheric condenser by a 9½" x 16" x 10" compound Reeves engine, which drives a Morris centrifugal pump, having a capacity of 9,000 gallons per minute. The dry vacuum pump is of the Williamson type, 12" x 24" x 18". Connected to the up-take from the turbine to the condenser, a 4" x 5" x 5" Knowles wet vacuum pump is used, which pumps any water of condensation from the steam, or water from the step bearing, into the supply tank from which the boiler feed pumps draw their supply.

In connection with the turbines, two 10" x 3" x 10" Worth-



Transverse Section of Power House

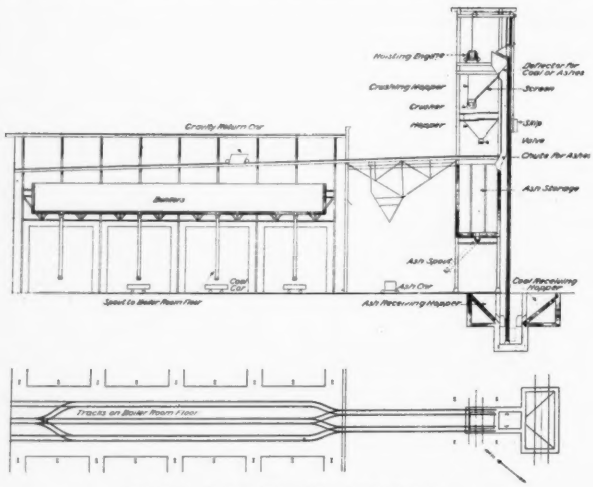
ington pumps are used together with a Wood accumulator for maintaining a constant water pressure of 600 pounds per square inch on the step bearings. Two Blake pumps are also used for pumping oil, which is used for operating the turbine valves. All pumps are equipped with Rochester force-feed lubricators and Liberty oil filters are used for purifying the oil.

From the generators, the 7,200-volt current is transformed in the power house by nine 700 kilowatt air-blast transformers to 36,000 volts, the line voltage. The Westville power station is also used as a sub-station and contains at the present time six 275 kilowatt step-down transformers, which reduce the 36,000 volt line voltage to 430 volts, at which pressure it is led into two 750 kilowatt rotary converters, which convert the current into 650 direct current for the third rail.

There are seven other sub-stations along the route at South Camden, Glassboro, Newfield, Clayville, Mizpah, Reega and Atlantic City, each of which contain two 750 kilowatt rotary converters and six air-cooled step-down transformers. The sub-stations are built of red brick, trimmed with limestone

trimmings, and each sub-station is equipped with a hand operated crane.

The transformers in the power house are all cooled with air-blast. Three Buffalo forge fans, 4 feet in diameter, are used, driven by 12 horse power motors. Two motors are of the induction type and the third is of the direct current pattern



Coal and Ash Handling Machinery

The fans drive the cool air into a room containing the high tension switches, after which the air passes through the transformers placed directly above the opening in the top of the room. Spacious ducts are also led to the main generators, which are also cooled with air-blast.

The 36,000 volt duplicate transmission line consists of six No. 1 B. & S. hard drawn copper wires, mounted on porcelain insulators. The line is protected from lightning by seven-strand galvanized steel cable 5/16 in. in diameter, strung for the entire length of the line on top of the transmission poles, 4

Sub-Station at Atlantic City, N. J.

feet above the nearest active wire, and provided with ground connections at every fifth pole. This arrangement is a supplementary adjunct to the regular lightning arresters.

The third rails are of the regular type, 100 pounds per yard, and are mounted on reconstructed granite insulators, spaced about 8 feet apart, the insulators being secured to the ties by means of a centering cup and lag screw.

All the rotary converters in the power house and sub-stations are started from the alternating current side. The step-down transformers are supplied with taps, giving one-third and two-third the working voltage, which supply the rotary converter until it comes up to speed when the full voltage is thrown on. Should the direct current side show the wrong polarity, a field reversing switch is provided for the purpose.

The power equipment of each car consists of two 200 horse power motors and the control system is of the automatic multiple-unit type. Each car has two trolleys and a third-rail shoe, and on the roof of the car there is a box containing the lightning arrester, trolley cut-out switch and trolley fuse.

The entire electrical equipment was installed by the General Electric Co., under the supervision of Mr. W. B. Potter and Mr. J. Elliot Hewes. Mr. A. M. Plummer is chief engineer of the plant.

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Recent First-Class Massachusetts License Questions.

The following questions were recently asked at a first-class engineers' examination, held at Boston, Mass.:

Considering a vertical cross-compound condensing engine, 2,500 horse power,

1. Give approximate diameter of each cylinder and length of stroke.

2. Give approximate economical number of revolutions per minute.

3. State economical boiler pressure.

4. Give approximate initial, terminal and effective pressure in each cylinder.

5. Draw approximate theoretical cards of each cylinder.

6. State economical point of cut-off in each cylinder.

7. Draw approximate indicator card of each cylinder showing economical compression and one-sixteenth of stroke late admission.

8. Calculate the nominal horse power of each cylinder by the cards you make.

9. State diameter of driving wheel and width of belt required to transmit the power.

10. Give diameter of driving pulley on shafting to secure speed of 400 revolutions per minute of line shafting.

11. How many different types of boilers are you familiar with?

12. Name the types of boilers you are familiar with.

13. How many different boiler seams do you know?

14. Name and describe each different seam you may know.

15. What size rivets should be used in a boiler ¼-in., ½-in., ⅜-in. in thickness?

16. What should be the pitch of the rivets?

17. How are the various kinds of braces secured to the boiler and made tight?

18. What kinds of boilers have stay bolts?

19. What is meant by pitting and what causes it in boilers?

20. What is meant by grooving and where do you find it?

21. Where do leaks occur in boilers? How can you tell a leak when there is no water in boiler, and where do you look for leaks?

22. What is a blister, what is the cause of it and what damage does it do to boilers?

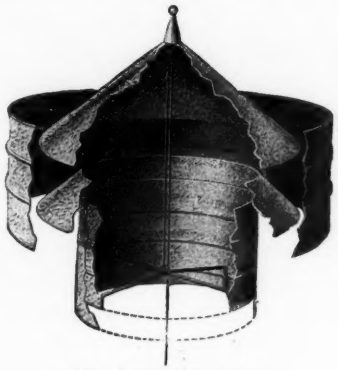
23. What is bagging in boilers and what damage does it do to boilers?

PROBLEMS OF VENTILATION

Methods of Supplying Fresh Air Under Different Conditions

The question of ventilation, particularly of engine rooms and workshops, is a subject which is attracting more attention every year, because it is becoming to be realized that men cannot exert their best thought, or exercise their normal energy, in places where the atmosphere is not of standard purity or where the temperature is excessive. Various devices are being used to attain the desired results, among which are the ventilator, the exhaust fan and the pressure fan.

In engine rooms or factories, which are built only of one story, the ventilator has been found to give good results, as it



The Burt Ventilator

allows the hot air, smoke or steam, which rises to the ceiling, to pass out freely. When, however, the engine room or workshop is situated in the interior of large buildings, other methods of ventilation must be used. Extended systems of piping and the furnishing of air at pressures suitable for ventilation require a cased fan, but whenever large volumes of air are to be moved against very low resistances the propeller fan will be found to answer the purpose. In general, it may be said that the term "fan" is commonly applied to any form of apparatus for moving air in which revolving blades of the propeller type are used, while the term "blower" is applied to fans which are enclosed in casings or housings. Fans of this latter type are called centrifugal fans, because the air is moved by centrifugal force and is thrown off from the tips of the revolving blades. As the air is thrown from the blades, it produces a certain pressure within the fan casing, which causes it to flow from the discharge opening and through the connecting ducts. In the meantime, air from the outside flows in through the inlet openings near the centre of the fan to take the place of that which is passing out through the outlet. When the fan casing has an inlet opening in one side only, it is commonly called an exhauster. Besides being used for ventilation, an exhauster is the type of fan most generally used for handling shavings from wood-working machinery, for removing smoke and gas from forges, dust from emery grinders, buffing wheels, etc. In practice, exhausters are often used for blowers, the discharge opening being in any position desired.

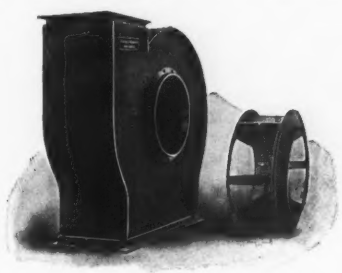
In a system of forced circulation by means of a fan, the action is positive and practically constant under all usual conditions of outside temperature and wind action, which gives it a decided advantage over natural or gravity methods; which are affected by the changes in wind pressure. This makes the forced circulation especially well adapted to the ventilation of large buildings where large and definite air quantities are required.

There are two methods of ventilation in use known as the exhaust and the plenum methods. The exhaust methods consists of drawing the air out of the building, and when this method is used a partial vacuum is created within the building or room, and all air currents and leaks are inward. In the plenum method, the air is forced into the building, and as all spaces are filled with air under a slight pressure, the leakage is outward.

The fan may be operated by a small engine of the horizontal and vertical type, which may be either direct connected or belted to the fan or it may be run with an electric motor. Electric motors are particularly well adapted for use in connection with fans, as they are easily controlled by a switch and starting box or regulator, and the motor may either be belted or direct-connected to the fan shaft.

The location of an electric propeller fan depends upon the conditions and the desired results. It may be placed in the wall through which the air is to pass or in a galvanized-iron flue with branch flues leading to the various points requiring ventilation. In some cases, especially in factories with low ceilings, the elevator shaft is utilized, the fan being placed in the top of the shaft, withdrawing the air which has previously circulated in the rooms.

The volume of air which a given fan will deliver depends upon the speed at which it is run, and the friction and resistance of the air through the air-ducts. In a pressure fan, the greater the pressure for a given resistance, the greater will be the amount of air delivered, and the greater the resistance, the greater will be the pressure required to deliver a given quantity of air. Most practical data on the action of fans are



The Green Fan Wheel and Housing

based on the results of tests, from which the following conclusions have been drawn:

1. The volume of air delivered varies directly as the speed; that is doubling the number of revolutions doubles the volume of air delivered.

2. The pressure varies as the square of the speed; for example, if the speed is doubled, the pressure is increased four times.

3. The power required to drive a fan varies as the cube of the speed; that is if the speed is doubled, the power required is increased eight times.

The above conclusions show that if double the quantity of air is required than that delivered by the fan, the power would increase eight-fold, so that it would probably be cheaper to put in a larger fan and run it at a lower speed. It has been found in practice that fans of the blower type, having curved blades, operate quietly and give good results when running at a speed of about 3600 feet per minute at the circumference of the wheel. The peripheral velocity of the wheel divided by 1.6 and multiplied by the area of the outlet, gives approximately the cubic feet of air discharged per minute. This applies to a standard fan which has double inlets and which delivers air to ducts of generous size.

A centrifugal fan, when enclosed in a case, has the ability, when run at a certain speed, to maintain a pressure corresponding to the velocity of the fan tips over an area which is called the capacity area or the square inches of blast. If this area be increased the pressure will drop, but if it is reduced in size the pressure will remain practically constant. The

The Sturtevant Propeller Fan

capacity area of a fan under ordinary conditions is given approximately by the formula.

$$A = D W \div 3$$

in which D is the diameter of the fan wheel in inches, W is the width of blade at the tip and A is the number of square inches of the blast, assuming the fan to discharge into the open air.

The principles of ventilation should be as closely adhered to in the winter months as in the summer, although the popular supposition is that cool air is good air and warm air is impure air. It is not a question of temperature, but of the amount of carbonic acid gas in the air. Air contains by volume 79 parts of nitrogen and 21 parts of oxygen, together with 4 parts of carbonic acid gas in 10,000 and some moisture. As 4 parts of carbonic acid gas (CO_2) is always found in the air, this is the standard of absolute purity. Authorities differ as to the amount of CO_2 allowable in the air. CO_2 itself is not injurious, yet, as it is a product of respiration, it is regarded as the index of the quality of the air and the amount present indicates the standard of ventilation. Except in hospitals, school rooms, etc., where a very high standard is required, about 12 parts of CO_2 is considered an average standard.

Every person therefore breathes in about 4 parts of CO_2 in every 10,000 parts of air and breathes out 400 parts. As a person makes from 16 to 24 respiration per minute and at each respiration uses 20 cubic inches of air, it can be calculated that to maintain a standard of purity of 12 parts of CO_2 per 10,000 17 cubic feet of air is required per minute per person or 1,000 cubic feet per hour. For much better ventilation as high as 30 or more cubic feet is allowed for each occupant of the room per minute.

The practical problems of ventilation require the introduction, first, of 20 to 30 cubic feet of air per minute for each occupant, and in addition sufficient air to provide perfect combustion to gas jets, etc., which are discharging the product of combustion directly into the room; second, the problem requires the fresh air to be introduced in such a manner as to make no sensible air currents. This problem is solved by the use of ventilators and fans as mentioned above.

In and around many factories, however there are other reasons why ventilation should be employed, which may be due to the character of the work performed. The conditions affecting the health of persons engaged in factories and other establishments is shown in a portion of the report of the State Board of Health of Massachusetts.

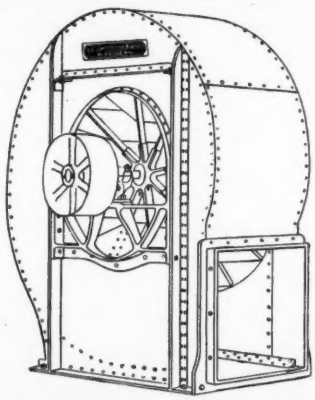
"The indoor occupations of chief sanitary interests are those which involve exposure to irritating and poisonous dusts; exposure to irritating poisonous and offensive gases and fumes; contact with poisonous substances; extremes of heat and excessive dampness.

"Of the several classes of dust—those of vegetable, animal, metallic and mineral origin—it is difficult to determine which is the most irritating to the respiratory tract; but the vegetable dusts are commonly so regarded, in spite of the well-known fact that the occupations in which the employes inhale minute particles of steel, glass and stone are remarkable for their high death rates from tuberculosis of the lungs. But not all of the dusts of one class are equally irritating; flax and cotton, for example, are more irritating than wood; steel is more irritating than brass; horn is more irritating than bone; granite is more irritating than marble, and glass far more than granite.

"Workers exposed to dusty atmospheres are especially prone to disease of the lungs, especially pulmonary tuberculosis, the constant irritation bringing about a condition of the mucous surfaces which more readily admits of invasion of the specific germs. Those who are exposed to poisonous dusts are, unless proper precautions are observed, likely to fall victims to chronic poisoning. The most dangerous of the metallic dusts met with in this investigation are those of lead and its compounds.

"Of the various gases and fumes to which workmen are exposed, those which are merely irritating are of far less importance than those which are poisonous in their nature. The irritating fumes cannot be borne in large amounts, and they cause the person exposed to seek the relief afforded by fresh air. In small amounts they cause slight tickling coughs and perhaps catarrhs. Of the poisonous fumes, the most

important and commonest met with in this investigation are those of naphtha and wood alcohol. Both of these substances are used in very many industries. Naphtha fumes cause various forms of intoxication, especially in women. Among the symptoms are dizziness, nausea and vomiting, headache, hysterical phenomena, disturbances of the circulation and respiration, and mental confusion. In the periodical literature of industrial hygiene are not infrequently reported cases of fatal poi-



Full Housing Blower and Exhauster Fan

soning therefrom. Of equal or greater importance are the fumes of wood alcohol, which agent is very largely used, as a cheap substitute for grain alcohol, in varnishes, etc. Of late years it has become well known that, taken as a beverage, wood alcohol is likely to cause death, preceded by total blindness; but it is not commonly known that exposure to the fumes has caused many cases of serious impairment of vision and not a few of total blindness, due to action upon the optic nerves."

This report covered cutlery grindings, stone cutting and polishing, cigarmaking, boot and shoe making and the rubber and lead industries. It was stated that there were two to three times as many deaths, proportionately, among grinders, polishers and cutters of metal, stone and other hard substances, due to diseases of the lungs, as among other male adults; that of 373 shoe factories, the ventilation of the majority was poor and distinctly bad, etc.

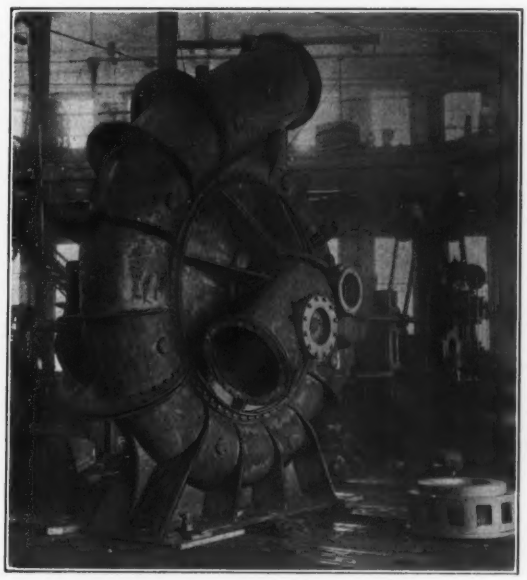
Every industry has therefore its own problems of ventilation to meet, the arrangement of which the engineer has control. The removal of dust in a planing mill where each machine is hooded and such a vacuum produced that the material is conveyed to dust collectors and the clarified air allowed to escape to the atmosphere, is a well-known application of the use of a fan. Close hooding on many machines in other industries connected to mechanical exhaust systems would aid in improving hygienic conditions in many other plants.

Experience has proved the value of good light and ventilation, and if the engineer has no control over the ventilation of the rest of his plant he should at least have his own engine room in healthy condition.

Large Centrifugal Pumps Used for Irrigation.

Two pumping engines, each having a capacity of 50,500,000 gallons daily, are being installed in the plant of the Trespalacious Rice & Irrigation Co., southwestern Texas, for irrigation in the Matagorda rice fields. These pumping units have a capacity greater than any ever installed in that section of the country. Each unit consists of a horizontal shaft, double suction centrifugal pump, direct-connected to a cross-compound Corliss engine. These units, which were built by the Allis-Chalmers Company, have no fly-wheels, the pump impellers supplying the necessary fly-wheel effect. The pumps have 36" discharge nozzles, and each unit has a capacity of 35,000 gallons of water per minute, equivalent to 50½ million gallons of water per 24 hours. The double suction, horizontal shaft design of pump allows the water to enter the pump from both sides, thereby eliminating thrust and danger of serious delays in operation. The pump casings, as shown in the accompanying illustration, are "snail shell" shaped, heavily ribbed, substantial throughout, and are cast separately from the side covers. The steam used by the engines will be condensed in a Tomlinson barometric condenser.

When in service on the rice fields, these engines will be used to pump about one inch of water over the surface of the entire field under cultivation after the new rice crop has grown to be one or two inches high. Then this height of water is gradually raised as the rice grows, until there are three or four inches of water over the field. The water is allowed to remain at this level until the rice heads up. When the time arrives for harvesting, the water is drawn off and the fields allowed to dry



50,500,000 Gallon Centrifugal Pump used for Irrigation

for two weeks. The crop is then harvested by means of machines, just as grain is harvested on the western prairies and threshed by machinery.

Big Marine Engines.

There are destroyers in our and other navies of the world which could cross the ocean at a record-breaking speed were it not for the matter of carrying the necessary coal, which would tax the capacity of the craft. An effort will be made to solve this problem by the construction of a 30,000 horse power craft driven by five gas engines, each of 6,000 horse power. These are the largest marine gas engines ever constructed, and because of the great economy of their operation it is expected that the boat will be able to cross the Atlantic Ocean in four days, depending alone on her own fuel supplies. The maximum speed of the boat will be 33 knots, but on the transatlantic trip it is proposed to maintain a speed of 30 knots all the time. The British Government has already experimented with marine gas engines, but not on this prodigious scale.

PUMPING AMMONIA

By W. H. Wakeman.

In every plant where ice is manufactured by what is known as the compression process, one or more pumps are used to compress ammonia, and as the design and construction of these pumps are subjects of much interest to engineers and others engaged in this work, either directly or indirectly, we present an illustration of one that is worthy of a full description, as it is of the horizontal double acting type, which is the most complicated of any in the market, yet a reasonable amount of intelligent care will keep one of them in continuous operation for months. This does not mean that it may be run for 8 or 10 hours per day, as an ice factory must be operated for 24 hours each day, for two reasons. It takes some time to get a plant into full operation, and during this time of preparation no ice is made, consequently it is desirable to make the time thus spent as low a percentage as possible of the whole in order to keep the cost of production within reasonable limits.

Another reason for this is that ice-making machinery is usually not run for twelve months in every year, unless the plant has a large storage capacity, in which case the loss is great, as ice will melt, and the cost of extra handling adds much to the total cost of production. As a general rule there is a brisk demand for ice during the hot weather, wherever an ice factory is well located, hence it is run all of the time in order to supply the demand.

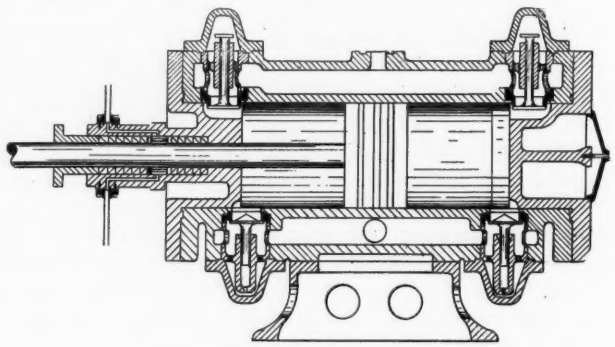
Ammonia is pumped when it is in the form of a gas, therefore it is much more difficult to pump than if it was in liquid form. The discharge pressure is high, and as the gas is very elastic, the clearance space, or in other words, the space between the piston and the valves, when the crank is on the centre, must be made small, as otherwise much power is lost. Suppose that 200 pounds pressure is carried and that the clearance is large. When the piston has reached the end of a stroke, this clearance is filled with an elastic gas. The return stroke is begun and this gas commences to expand, and, of course, the pressure is quickly lowered, for in accordance with Mariotte's law, as the volume of a gas is doubled its pressure is reduced one-half, but the piston must travel a respectable percentage of the stroke before the pressure is lowered enough to let the suction gas enter, as the pressure carried on this side is usually one-tenth of the discharge pressure, and during this time the pump or compressor is not doing any useful work.

The illustration shows the piston in the middle of its stroke with all valves closed, as the machine is now at rest. Suppose that it is started into operation and the piston moves from left to right hand. The upper right hand valve will then be closed, thus preventing ammonia from going back into the suction pipe, and the lower valve will be open, allowing the gas to go into the discharge pipe. At the same time the upper left hand valve will be open and the lower one closed as the piston is then drawing in a charge of gas. Having completed its stroke the piston begins to move in the opposite direction, which causes all of the valves to assume positions directly opposite to those mentioned in the above description.

As these valves are subjected to very hard service, they wear rapidly (at least in some cases), but the fact that they often break under the heavy pressure to which they are subjected, is a much worse feature, because the pieces may drop down into the cylinder and cause a wreck that will probably be both dangerous and expensive.

These valves are designed and located so as to overcome this objection as far as possible, as the lower ones are below the cylinder, and if the upper ones break they fall into the bottom of a receptacle provided for this purpose.

The stuffing box is very deep, so as to hold five rings of packing in one part of it, and four in the other, as it is very difficult to prevent the escape of ammonia around the piston rod, where the pressure is so high. If a shallow stuffing box is provided, the gland must be forced inward until much pressure is brought to bear on the rod, which will score it and destroy the packing, as it is very difficult to lubricate such a joint. The illustration shows a device by means of which oil is forced into the central portion of this stuffing box through one pipe, and carried away by another, thus affording one of the best known plans for supplying first-class lubrication to the rod without waste of oil.



Double Acting Ammonia Compressor

Much difference of opinion exists among engineers concerning the comparative merits of double acting compressors (see illustration), when compared with those of the single acting type, in which ammonia is drawn in at one stroke and expelled at the next. Advocates of the former show that their machines are very compact, hence can be placed where space is limited, but, as already mentioned, they are complicated. Those who favor the latter show that their machines are very simple in design and construction, but when we consider that two compressors are required to do as much work as one of the double acting type, it becomes plain that there is really but little difference between them.

Another point that receives much attention is that while some of them are in horizontal form, others stand vertically. The former are easily taken care of, as it is not necessary to climb a ladder to oil them, and this point is favored by the working engineer. It is also in favor with those owners who have an abundance of floor space, but only limited head room.

Of course the working engineer can take care of any kind of a machine on which he is employed, therefore if he gets a

good chance to operate a vertical compressor, he cheerfully climbs the ladder as often as necessary, and he finds that the cylinder of this kind of a machine is easily lubricated, hence he can get along with little cylinder oil, as the piston (which may weigh a ton or more), is suspended or rather upheld in the centre of the cylinder, instead of sliding on the bottom of it, therefore friction is reduced to a minimum.

The claim that a vertical machine occupies little space, is made very prominent, but it is valuable or otherwise according to conditions. If the prospective purchaser is situated so that floor space is valuable the vertical type is favored, but he should not forget that it will occupy two stories of his factory, therefore the floor space occupied is really double what the foundation covers. If the points that are found in this article are given due attention, it will save more or less disappointment, and assist the manufacturer in selecting a machine that will be satisfactory and profitable.

MERCURY LAMPS

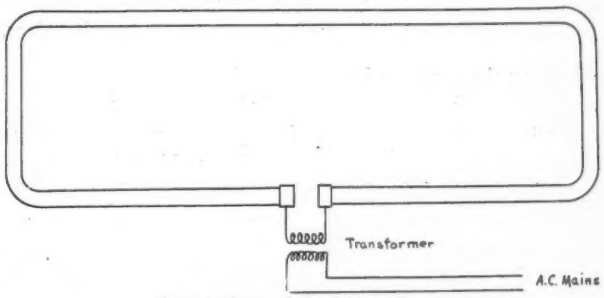
By Jacob Glogau.

At the present time one of the principal improvements in electric lighting is to have an electric light which will give a light similar to daylight. Up to date we have three kinds of lights which are claimed to give off this kind of light; they are the Hewitt mercury vapor lamp, the Bastian mercury lamp, and the Moore electric lamp.

The Hewitt lamp was invented by Mr. Peter Cooper Hewitt, of New York, and derives its light from the gas given off by the mercury, a high state of incandescence being caused by the passage of the electric current. The tubes are exhausted to a high degree by means of a vacuum pump, and are sealed at each end. There is a metal wire sealed in the tube at each end and these wires lead to the electrodes. The electrodes are of mercury. As the tube is sealed at each end the mercury vapor cannot escape. The lamp is supposed to give the greatest efficiency of any lamp used. It consumes about .3 of a watt per candle-power, therefore its efficiency is about twice that of an arc lamp and about eight or nine times that of an ordinary incandescent lamp. The light given off is supposed to be a brilliant white, but it seems to give a greenish light. It is a soft light, not straining on the eyes, because the red rays are lacking. The lamp runs with steadiness and does not make any noise. The lamp can be used satisfactory for lighting offices, draughting rooms, factories, machine shops, newspaper pressrooms and for photographic work.

The operation of the lamp is as follows: The mercury vapor as it exists in the lamp possesses a high resistance to the passage of the electric current, and before the lamp will light this resistance must be considerably lowered. There are two ways of accomplishing this: by the high potential method and by the tilting method. In the first method the current is passed through an inductance coil and by means of a quick break switch the discharge of the coil passes through the lamp, thus cutting down the high resistance and furnishing a path for the current. In addition to the inductance coil a condenser acting band is used to cut down the resistance of the negative electrode. The tilting method is more simple; the lamp is tilted to a certain degree and the mercury flows to the other electrode, thus establishing a metallic connection, and then the lamp lights. The life of the lamp is about 1500 to 2000 hours, gives off very little heat, and can be operated on direct current circuits of 50 to 150 volts.

The Bastian mercury lamp consists of a glass tube made from Jena tubing, the tube being about ten inches long, the leading wires are of platinum; these wires are flattened into a rivet head form on both sides of the glass. When the tube is hot the greater expansion of the platinum closes up the hole, and when the tube cools the greatest contraction of the platinum grips the glass and seals the aperture. The electrodes are the same as that of the Hewitt lamp. The tilting system is used, but working automatically. This is done by a solenoid which pulls a soft iron armature, which is fastened to the tube-holder, thus tilting the tube and forming a metallic circuit between the two electrodes. The difference between the Bastian lamp and some of the other makes is that the mercury is carried by



Connections of the Moore Lamp

evaporation from the negative to the positive electrodes, where it condenses and then runs back, and in the Bastian, the tube being very small, does not allow this action and is dependent upon the correct distribution of the mercury. The positive mercury surface being larger than the negative, it follows that the current density is less and the surface is cooler, thus condensation occurs, and at the negative terminal the surface space is small, thus the current density is large, therefore the negative terminal is very hot, causing evaporation of the mercury. This action, therefore, counteracts the effect of the electric potential to carry the mercury in the opposite direction, viz: from positive to negative.

By shaping the tube so that as the mercury collects at the positive the electrode surface is moved farther from the cooling effect of the mass of mercury in the large positive bulb, condensation is retarded, and a balance is automatically arrived at, and maintained, the effect being strengthened by a reverse action occurring at the negative. The lamp consumes about .4 watt per candle power on 220 volts. Under these conditions the lamp gives a poor light. To give the proper light, it consumes about .8 watt per candle power, or twice as much as the Hewitt lamp. The lamp will operate under varying cur-

rents—that is, voltage variations of 150 to 300 volts, without doing any damage to the lamp.

There is no special light given off by the Bastian lamp. It can give off a yellow, green, blue, and a light violet color. The light given off by this lamp is of great use in photographic work, the lamp under favorable conditions has a life of about 10,000 hours. The lamp is used mostly in Europe, but will be shortly introduced in the United States.

The last of the vapor lamps is the Moore electric lamp, invented by D. McFarlan Moore. This light is different than the two other lamps. In the first place the tube is permanent in the Moore light, and in the second place the light given off by the Moore lamp is entirely different. The tube is made in all lengths, from 3 feet up to 155 feet, which is the largest so far attempted. As you notice, the Hewitt and the Bastian used a sort of a metallic gas, or, in other words, mercury vapor. The Moore light does not make use of it on account of the objection to the color, but uses a new non-metallic gas, which is the secret of the invention. The light given off by the Moore lamp is of a light pink color (seen from a distance), or when near it, resembles the light given off by the sun. To allow such long tubes, a new trade is made use of, and that is known as glass plumbing. The room which is to be lighted is fitted up with 1¾-inch clear glass tubing of eight and a half feet lengths, and are joined together by means of a torch until the complete area is covered to make clear. The lamp is one complete tube. The lamp operates on alternating current circuits and has a life of 2000 hours. All dangers of live wires causing fires is eliminated by this system of lighting. This is done or obtained by installing what is known as the safety proof box, which contains the necessary switches. The accompanying figure shows the connections of the Moore lamp. One of the most principal uses of the Moore lamp is its value to the photographer. The time is drawing near when we will do away with the incandescent lamp and use the different styles of vacuum tube lamps. The first experiments in regard to vapor tube lamps took place as far back as the latter part of the seventeenth century, when a French scientist noticed that while handling a barometer the friction of the mercury in the tube seemed to give off a peculiar light. Further experiments took place, but nothing of real value as far as commercial use is concerned took place until the twentieth century, when the Hewitt, Bastian and the Moore light came into practical use.

ELEMENTARY STRENGTH OF MATERIALS

Stress, Elastic Limit, Modulus of Elasticity and Practical Problems

By Carl S. Clark, S. B.

During the course of an engineer's reading there are many times when an understanding of the common terms used in connection with the strength of materials would be very useful to him. There are also many cases during his daily work where a small amount of simple figuring, supplemented by good judgment, is far better than the pure guess-work, which would otherwise necessarily be used. The first step in obtaining this familiarity must be the understanding of the definitions of the terms.

When an outside force acts upon the body, as for example, a piece of metal, it sets up a certain force within the body, which may be considered to oppose the outside force. This internal opposing force is termed a "stress" and may be defined as a force within the body which resists a force acting externally. A stress may be distinguished from a force in that it represents the intensity of the action, rather than the amount. Stress is usually measured by the force acting upon a certain definite area, such as in pounds on an area of one square inch. For example, a force of 40,000 pounds acting on a piece of material whose area is four square inches will produce a stress of $40{,}000 \div 4 = 10{,}000$ pounds per square inch, or again, a force of 60,000 pounds acting on an area of six square inches will also produce a stress of $60{,}000 \div 6 = 10{,}000$ pounds per square inch. It can thus be seen that the stress is dependent not alone upon the force acting but also upon the area of the body acted upon.

When a force acts upon a body, producing a certain stress, it also causes a slight change of shape, or, as it is termed, a "strain." We may then define a strain as the deformation produced by a stress. The terms stress and strain are many times used with the same meaning, so that in this article we will not use the latter.

For the present purpose we may divide stresses into the following classes, viz.:

(a) Tensile stress.
(b) Compressive or crushing stress.
(c) Shearing stress.
(d) Bending stress.
(e) Twisting stress.

(a) Tensile stress is that caused by a direct pull, as when a weight is suspended from the end of a rope or tie rod.

(b) A compressive stress is that caused by a direct thrust or push, as on a piston rod during the outward stroke of a piston, or a column under the floor of a building.

(c) A shearing stress is that caused by a tendency to "shear" the body, or to cause one portion of the body to slide past the other portion. The best illustration of this stress is a rivet in a riveted joint, the sharp edges of the plate tending to cut or shear the rivet at the line of the joint.

(d) A bending stress is one caused by bending the body. This stress is a combination of tension and compression stresses, the fibres on the concave side being in compression, while those on the convex side are in tension.

(e) A twisting stress is caused by twisting the body around its axis. This stress exists in a shaft which is transmitting power.

In practice these stresses do not always occur separately, but the body may be subjected to two at the same time. For example a line shaft may have a twisting stress due to the power which is being transmitted, and may also have a bending stress from the pull of the belt. Again, the crank pin in an overhung crank, is subjected to a double stress of shearing at the face of the crank, and of bending due to the fact that the centre of pressure is at a distance from the face of the crank. In cases

of double stresses each stress may usually be allowed for independently, although in complicated cases it is necessary to combine them by special rules.

The "strength of materials" may be considered under:

(a) "Ultimate" or breaking strength, which is the force required to break down the material in any one of the above ways and render it useless.

(b) Safe or "working" strength is the stress to which the material may be subjected under the actual or working conditions, without damage to the materials, or danger of its giving away.

(c) It is plain that a piece of material cannot safely be loaded to its breaking strength, it is thus possible to utilize only a part of its total strength. The working strength can then be only a certain proportion of the breaking strength. The proportion of the ultimate or breaking strength which may be safely used under the working conditions, is termed the factor of safety. For example, if the breaking strength of a piece of material is 60,000, and it is safe to load it only to 12,000 pounds, the factor of safety, is $12{,}000 \div 60{,}000 = 1/5$, or as it would be termed, a factor of safety of five.

It may be otherwise defined as the proportion which the breaking strength bears to the working strength. To obtain the working strength the breaking strength is divided by the factor of safety.

(d) The tensile strength of a material may be defined as the force which would be required to pull apart and break, a piece of material one square inch in area.

(e) The compressive or crushing strength of the material is the force which would be required to crush and render useless, a piece of the material one square inch sectional area.

(f) The shearing strength of a material is the force which would be required to shear off a bar of the material of one square inch sectional area.

Bending and twisting stresses being combinations of the others, cannot be defined directly.

Elastic Limit.—When a body is subjected to a stress, it yields slightly, a small change of shape or deformation, being thus produced; upon the removing of the stress the body returns to its original form. As the stress increases, the deformation increases always in the same proportion, and the body will return to its original shape upon removal of the stress. This proportion of stress and deformation holds true up to a certain point beyond which any increase in the stress produces a greater deformation and the body does not return to its original shape upon the removal of the stress. This point is called the "Elastic Limit" or the "yield point."

To make this plainer, suppose a bar of iron to be suspended with a load of 1,000 pounds at the end. Suppose that under measurement it is found to have stretched 1/10 inch. An increase of 1,000 pounds in the load will produce an additional stretch of 1/10 inch. Suppose this rate of increase of load and stretch to continue until the total load is 10,000 pounds, and the total stretch $10/10 = 1$ inch. Up to this time each addition of load has produced an exactly proportionate increase in length. Suppose now that an additional stretch of 1,000 pounds be added to the load and the additional stretch be found to be 2/10 inch and that for a further addition of 1000 pounds an additional stretch of 3/10 inch is found. It is evident that above 10,000 pounds the stretch is increasing more rapidly than below it, and that a certain further addition of the load will break the bar. The load of 10,000 pounds at which the elongation ceases to be proportional to the load is then the elastic limit. The elastic limit should never be less than one-half the breaking strength, and may be as high as two-thirds of it.

Modulus of Elasticity.—We have seen from the proceeding illustration that up to the elastic limit, a body changes shape in proportion to the load applied. If now we take a bar of iron, say one inch square, and apply a series of increasing loads to it, we can measure the elongation for each load. Suppose now, that there were no elastic limit and that the bar always stretched the same for each additional load. We should then finally stretch the bar by an amount equal to its own length, or its final length would be double its original length. The force which would be required to do this is called the modulus of elasticity. While this process is, of course, impossible, it is useful to illustrate the principle. The modulus of elasticity can only be used when the body is stretched below the elastic limit.

To illustrate this let us suppose a bar of steel one inch square and ten inches long; we wish to find how much it will be stretched by a load of 36,000 pounds. The modulus of elasticity of steel is 30,000,000 pounds. In other words, a force or load of this amount would, if such a thing were possible, stretch the above bar ten inches, making it ten inches long. The elongation produced by any force will then be in the same proportion to ten inches that the force is to 30,000,000 pounds. The load of 36,000 pounds will then produce a elongation of $36{,}000 \div 30{,}000{,}000$ in ten inches, or .012, so that the final length if 10.012 inches.

This property is very useful for figuring the elongation or compression of a piece of material under a force. It is very easy to use, it being only necessary to remember that the elongation or compression bears the same ratio to the length of the piece, that the force acting bears to the modulus of elasticity. Although the example chosen to explain this property was one of tension, the principle applies equally well in compression.

Cast Iron.—The tensile strength for the average quality is 18,000 pounds per square inch, which, with a factor of safety of 6, gives 3,000 pounds per square inch as a safe working load strength for use in ordinary cases. The crushing strength of cast iron is high, about 80,000 pounds per square inch, a safe crushing strength being about 12,000 pounds per square inch. The modulus of elasticity is about 17,000,000.

Wrought Iron.—The average tensile strength is about 45,000 pounds per square inch, with a working strength of about 7,500 pounds per square inch. The shearing strength of iron rivets is about 40,000 pounds. The modulus of elasticity is about 28,000,000.

Steel.—The tensile strength of the usual structural boiler or machinery steel is about 60,000 pounds per square inch, with a safe working strength of 10,000 or 12,000, according to the steadiness of the load. The shearing strength of steel rivets is about 45,000 pounds per square inch. The modulus of elasticity is usually taken at 30,000,000 pounds.

Examples.—(1) Required the size of four tie rods to support a floor carrying a weight of 80,000 pounds; then $80{,}000 \div 4 = 20{,}000$ pounds supported by each rod. Allowing a

working strength of 10,000 pounds per square inch gives 20,000 ÷ 10,000 = 2 square inches, area of tie rod. This will be found to agree with a diameter of about 1⅝ inches.

(2) Required number of ¾ inch steel rivets necessary to withstand a pull of 90,000 pounds. The area of a ¾-inch rivet is .44 square inch. Allowing a shearing strength of 45,000 pounds per square inch each rivet will sustain 45,000 × .44 = 19,800 pounds. To sustain the 90,000 pounds will require 90,000 ÷ 19,800 or 4.52 rivets, we shall therefore need 5 rivets.

(3) Required the size of through stays on a boiler head eight inches apart for 100 pounds per square inch pressure. Area supported by each stay = 8 × 8 = 64 square inches. 64 × 100 = 6,400 pounds load on each stay. Allowing a working strength of 6,000 pounds per square inch, 6,400 ÷ 6,000 = 1.07 square inch area. This corresponds to a diameter of about 1 3/16 inches.

(4) A cylinder head of a 12-inch cylinder is held in place by ten bolts ¾ inch effective diameter. Steam pressure 120 pounds. What stress is on the bolts?

Area of 12-inch head = 113.1 square inches.
Total load on head = 113.1 × 120 = 13,572.
Load on one bolt = 13,572 ÷ 100 = 1,357 pounds.
Area ¾-inch bolt = .44 square inches.
Stress on bolt = 1,357 ÷ .44 = 3,084 pounds per square inch.

(5) Require the size of piston rod for this engine, allowing a safe working strength of 3,000 pounds per square inch in the rod.

Load on piston (same as load on head above) = 13,572 pounds.

Area of piston rod = 13,572 ÷ 3,000 = 4.52 square inches, Diameter of rod corresponding about 2⅜ inches.

With the rules as stated and the few illustrations given, no difficulty should be found after a little thought, in figuring the simple stresses and in proportioning simple parts to the loads put upon them. A little time and thought spent in this way will many times lend a feeling of certainty as to a certain part being strong enough to do its work.

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LOUISVILLE TO PROHIBIT SMOKE.

President of the Engineers' Club Gives Some Sound Advice About Smoke and Its Prevention.

At a recent meeting of the Commercial Club, of Louisville, Ky., Mr. Edwin S. Hallett, President of the Steam Engineers' Club, of Louisville, gave the following advice on Smoke Abatement, a subject which is stirring the citizens of that city, as an ordinance has been introduced in the local legislative body requiring all public buildings, apartment houses, hotels and manufacturing establishments, using a certain amount of coal daily, to fit their furnaces with smoke consumers:

"It would appear to those who are interested only in a clean city, that the smoke nuisance is merely a matter of a city ordinance which should be passed without further consideration. The history of this question in other cities is that a vigorous campaign of popular education has been necessary. Even power users and their advisers are often skeptical of the success of smokeless furnaces or are deterred by estimates of higher cost.

"In the first place, it must be put down as an established fact that smokeless furnaces are practical and economical. They are past the experimental stage, although improvements will undoubtedly be made. Let us examine the methods by which it is best done. These may be classified into three groups, as follows: (1) The mechanical stoker; (2) smoke-consuming furnaces, hand-fired; (3) smoke consuming attachments to hand-fired furnaces. In the first place, it must be conceded that the engineer may so handle any furnace as to make it smoke, a better knowledge of the art of firing is needed in many instances, and a higher order of intelligence is required to properly handle any furnace. Smoke is produced in the following manner: Coal contains a volatile matter of gas and fixed carbon or coke. The proportion of volatile matter to fixed carbon varies greatly in different coals. When a quantity of fresh coal is shoveled into a hot furnace the gas is driven off in great quantities. If this gas, which is mixed with air, rises up against the comparatively cool boiler, it chills the mixture to a point below the burning temperature. The furnace temperature is about 1,400 degrees, and the boiler about 350 degrees, which is about a thousand degrees' drop. This is where the smoke is made. Every smoke consuming furnace must correct the evil at this point.

"Let us examine the three classes mentioned above. The mechanical stoker carries a thin layer of fine coal slowly into the fire. The fresh coal is at the extreme front or edge, and the volatile matter, small in quantity, must pass over the white hot flame before reaching the water-cooled surface of the boiler. Some stokers are better than others, but any of them intelligently used, and not crowded beyond capacity, are very nearly free from smoke.

"The second group includes such as the down draft and the Dutch oven. The fire in the down draft is supported on water circulating tubes, the draft passing down through the coal toward the lower grates, which are provided to catch all coal falling through the tubes. Fresh coal is applied as the mass becomes choked, and the volatile matter is drawn through the incandescent heat below, and does not strike the boiler until it reaches the last third of the shell. When fired frequently, and no holes are permitted to come into the fire, it is very nearly perfect as to smoke.

"The Dutch oven consists in building the grates forward from the boiler and arching with a low fire-brick arch. The brick become white hot and the fresh gases striking this combine with the oxygen and no smoke is made. This is also very effective when properly handled. The Dutch oven feature attached to a stoker setting makes an ideal and most economical furnace.

"The third group of consumers may be called devices. They consist of jets of steam and a large supply of air admitted over the fire for a few seconds after firing. It is different in principle from the first two. They raise the temperature and make a natural combustion, while the last seeks by excess of air and steam to combine the volatile matter, which it does in a very satisfactory manner. It has the disadvantage of reducing the draft and costs something for steam. It also tends to lower the temperature of the furnaces instead of raising it. It has one great point in its favor, of being easily attached to a setting already installed at low cost. It removes from the objector his last prop. It forestalls any criticism of the city law-making body in passing an ordinance against smoke.

"To interest some manufacturers it must be shown that smoke consumption is economical. In the best-constructed boiler plants about one-fourth of the heat is lost in the flue gases. Every item short of perfection counts heavily against efficiency. If the gas of the coal is not burned in passing through the heat of the furnace it never will be. It is not the visible smoke only that is lost; much of the combustible gas is not visible and is lost with the smoke. Smoke is a sign of loss as pain is a symptom of disease. Another source of great loss is produced by the soot coating the heating surface of the boiler and in filling the tubes to prevent the transmission of the heat already made.

"Every business man who studies to stop the losses in his business cannot permit his chimney to smoke and have an easy conscience. It is a lamentable fact that very few steam users in the city know what they are getting for their money spent for coal. They do not know how much they are losing by poor equipment.

"An ordinance providing for all new plants in the future to be equipped with an acceptable smoke-consuming furnace will not be objectionable to any one. Set a reasonable date in the future for the completion of all other consumers with an inspector and a good-sized penalty for the violation and Louisville will soon be not merely a great manufacturing city, but a clean manufacturing city. No matter how many ordinances may be placed on the books, it is important that the agitation and education be kept up until all are convinced of the wisdom of the measure."

Removing a Two-Ton Chimney Cap.

Swinging 200 feet in the air from a rope and tackle, John Hassler and his assistant performed the difficult task of removing a two-ton metal cap from the top of the brick chimney at the works of the William Sellers Machine Co., Philadelphia.

At Work on Chimney, 200 Feet in Air

For precautionary purposes, the company, fearing that the eight sections of the cap could not much longer stand the ravages of time, decided to have the entire cap taken down. The top of the chimney is thirteen feet in diameter and access to the top could only be had through the inside of the chimney through a sixty-five foot underground flue, filled with soot and gases. The lumber with which the scaffold on the top of the stack was built had to be taken through this flue, and, in doing this, the two men were twice nearly overcome with gas.

Each of the eight sections weighed 550 pounds, and they were found to be in a bad state of corrosion, as were the bolts that held them to the sides of the stack, and owing to the roof of the building being beneath, it was with the utmost care that the sections were lowered to the ground. The new sections were sixteen in number and not so difficult to handle.

After the steeple-jacks had once reached the top of the smokestack, they rigged a tackle which connected with an iron stack about 200 feet high and about seventy-five feet away. Over a rope stretched across this chasm, the two men glided back and forth with ease in going to and from the top of the chimney. The iron stack was equipped with an iron ladder which they used in going up and down to their work.

Value of Coal.

There is a growing custom among the large industrial concerns which are required to make very large purchases of coal to pay for this fuel on a basis of the thermal units contained therein. This system has now been adopted by the United States Government, and provision has been made for such tests.

Wherever coal is used in sufficiently large quantities a 100-pound sample will be selected from the coal as it is delivered, and this will be crushed until there are no pieces more than one-half inch in diameter. This must be thoroughly mixed and a portion of it placed in a jar and sealed and sent to the testing station in Washington, where it will be carefully examined to ascertain if it comes up to the required standard.

Payment will be made on a basis of the price named in the proposal, corrected for variations of the heating value and ash, as shown by the analysis, either above or below the standard established by the Government. For instance, if it be found that the fuel contains 2 per cent. more British thermal units than that named in the standard the price paid will be 2 per cent. more than that agreed upon.

Electrician Survives 11,000 Volts Three Days.

While working on the new electric overhead system of the New York, New Haven and Hartford railroad, James McDonald, an electrician, lost his balance, and, to save himself from falling, seized one of the large feed wires with one hand and a signal rod with the other, with the result that 11,000 volts passed through his body. Other electricians hearing his cries, hurried to his assistance and with the aid of their rubber gloves they managed to break his hold on the wire. He survived the shock for three days, although his hands and arms were badly burned and his body swollen to twice its normal size. When an examination was made on his body it was found that the electricity had ruptured nearly all the arteries in his heart.

Some one asked Thomas A. Edison, "Don't you believe that genius is inspiration?" "No," he replied, "genius is perspiration."

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Unfair Examination Questions.

There is probably no one thing that interests the engineer more, especially in States where they have license laws, than a discussion of the questions that are given at examinations for engineers. Those who have passed an examination and who have received their coveted license feel like patting themselves on the back, while those who have been turned down often feel that there is no hope for them, and for some time after the seige at the torture chamber and in the chamber of horrors, as the examining room and the room in which the apparatus is kept, are aptly called, they are very desirous of knowing just why they failed and how they can improve themselves so that they will be able to pass another examination when the time comes.

Several of the questions which seem to be a favorite among examiners are in reference to the size of cylinder, economical number of revolutions, approximate, initial, terminal and effective pressure of a cross-compound condensing engine, and it seems to be those questions upon which most engineers are turned down. We have been asked about these questions so often and the appeal for help in this direction has been so urgent that we cannot refrain from saying that the questions are manifestly unfair to the practical engineer. Personally, nothing pleases us more than to dabble in the mysteries of differential and integral calculus and to solve the various formulas of thermodynamics as they apply to the heat engine, but some questions asked by examiners cannot be positively solved even with this comprehensive knowledge.

It has been said, and it is undoubtedly true, that those who know the least can often answer the most profound questions best, because they are not troubled by the doubts and different aspects which come to a man with a wide knowledge of the subject. The more one knows about the design of a steam engine, the more loath he will be to say arbitrarily that a certain size engine should have cylinders of certain sizes. There are so many different conditions that creep in, when this subject is considered, that the answer which one man would give would seem entirely wrong to another. In the design of compound and multiple expansion engines, it is still an open question whether it is best to design the cylinders so that the same amount of work shall be done in each cylinder or whether it would not be better to allow the same range of temperatures in each cylinder, letting the resultant horse power come what it may. Then again, cylinder condensation and re-evaporation comes in, and, unless they are considered along with other things, the results found by calculation, according to theory, will be quite different than those found in practice.

Every designer of a steam engine has his own notions on the above subject, and almost every manufacturer of engines will quote a different size engine to give the same rated horse power, so that it should not be expected that the average engineer who has had experience around perhaps only one or two compound engines should be able to figure just what is taking place in an engine about which he only knows the total horse power. Certainly, the examiners cannot know those things themselves, or else they would not make all the applicants quake who come before them. Let an examiner take an examination on questions that are widely different than the ones he is in the habit of giving, and it is fair to assume that he would not pass with flying honors.

Engineers' examinations are good, for they put the man

upon the same mettle that is often required of him in other cases of emergency, and when the questions are properly gauged and weighted they should show the knowledge of the applicant, but when questions are given about which even the highest authorities on design differ, it is stretching a point to say that these examinations are within the scope of the law, the failure to answer which, causes the applicant to be refused a license which otherwise he should rightfully possess.

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Excitation of Synchronous Motors.

Synchronous motors, which are widely coming into use for power purposes, possess certain features of excitation which are often not understood. Like every other piece of apparatus, they have their advantages and disadvantages, but when they are intelligently operated, their advantages may be said to outweigh their disadvantages. If there was no armature reaction and the armature circuit was not self-inductive, the current taken by a synchronous motor would always be in phase with its electro-motive force and the counter electro-motive force generated by the armature would be directly opposed to the impressed electro-motive force. Such an ideal condition is, however, never attained.

The armature of a synchronous motor exerts a strong reaction upon the magnetic flux of the field magnet and like any other magnetic body encircled by conductors which are traversed by alternating current, it is highly self-inductive. Therefore, if an alternating current be passed through the winding it will lag behind its electro-motive force by reason of the reactance of the armature, whether the armature be rotating or at rest. The only other electro-motive force that opposes the impressed electro-motive force, besides this self-induction electro-motive force, is the counter electro-motive force generated by the rotation of the armature in the magnetic field, the same as in a direct-current motor, and the value of this counter electro-motive force depends upon the strength of the field current as in a direct-current machine.

Unlike a direct-current motor, however, the field excitation and consequently the counter electro-motive force of a synchronous motor do not affect the speed of the machine, because the speed must have a fixed ratio to the frequency of the alternating current which supplies it, and this cannot vary unless the frequency varies. Therefore, altering the field excitation does not affect the speed, but only alters the value of its counter electro-motive force and shifts its phase.

It can thus be seen that changing the strength of the current in the field alters the power factor of the circuit. Assuming a constant load on the motor, only a slight change in field excitation will alter the counter electro-motive force, so that the amount of current required for a given load is the least when that current is in phase with its electro-motive force. If the field excitation be reduced, the counter electro-motive force will be reduced and the current will lag to the extent that the field excitation is reduced, and should the load remain the same, the armature current will be increased, and, consequently, the resistance drop and impedance drop will be increased. It is evident, therefore, that with the load constant, if a certain field excitation allows a lagging current of a certain value to flow, a leading current of precisely the same value can be obtained by strengthening the field.

To get the best efficiency, the excitation should be such that the product of the impressed electro-motive force and armature current will represent the number of watts used by the machine. There are other conditions, however, where it is advisable to increase or diminish the inductance of the system to which the motor is connected, in which case the current can be made to lead or lag the impressed electro-motive force until the proper conditions on the line are attained.

When fixing the field strength of a synchronous motor, there are three methods which may be used. One is to let the current lag at small loads, come into phase at about average load and lag slightly again at heavy loads. Another method is to run the motor under-excited so that it is usually at a minimum, but never zero, and the third method is to make the current lead at light loads, pass through zero at medium loads and lag with heavy loads.

It is highly desirable for economy in transmission, however, that the product of current and electro-motive force should be a minimum for the desired load, which condition can be fulfilled by regulating the fields of the synchronous motors on the line.

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Anthracite Coal For Producer Gas Plants.

When the gas producer for the generation of gas for the gas engine first came into use, it was probably natural to think that bituminous coal was the cheapest and best fuel to use for the purpose, and it has been along those lines that all forms of activity in the development of the producer power plant has taken place. Owing to the difficulty of properly cleaning the gas and the consequent difficulty encountered in the engine, anthracite gas producers are being experimented with and they are found to not only give better satisfaction, but they can be operated more cheaply than those of the bituminous type. The difficulty of cleaning the gas in producer gas plants using bituminous coal has always been and still is one of its prime objections, owing to the fact that lampblack, which is one of the by-products in the gas, does not adhere to a wetted surface and is difficult to filter. In the ordinary plant, the gas is first passed upward through a wet scrubber containing several tiers of small coke constantly wetted with water sprays. Emerging from the wet scrubber, the gas enters the dry scrubbers which are generally filled with excelsior or some like material, and are connected up in parallel so that the velocity of gas will be reduced for the better purpose of cleaning and drying it. With all these precautions, however, the gas is likely to enter the engine in a dirty condition.

The advantage in using anthracite coal lies in the fact that it gives a very much cleaner gas, which is easier to handle and that the small sizes can be used to advantage, thus giving a cheaper fuel. Buckwheat No. 1 to Buckwheat No. 3 can be used in the anthracite producer and except in places where bituminous coal is the native fuel or where the freight rate would make the price of these diminutive sizes quite expensive, it is expected that anthracite coal will be the coming fuel for gas producers. It is said that even low grade fuels can be used with success, buckwheat No. 3 having been used, containing as much as 23 per cent. of ash. There are hundreds of thousands of tons of these low grade fuels around anthracite mines which are the by-product of production, of which a large portion in the form of culm is still useless.

If culm, which costs about 15 cents a ton at the mine, could be used successfully in gas producers, then gas engine and gas producer plants would become very interesting propositions.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Engineers Now All Agree that Answer to A. R. G.'s Problem is 22.87 Feet.

EDITOR THE PRACTICAL ENGINEER:

As I see in the May issue that not a single correct answer was published in answer to A. R. G.'s tank problem, I will submit the following:

Let P = pressure in gauge pipe before water reaches lower end or 14.7 pounds.

P_1 = pressure necessary to cause gauge to register 5 pounds, or 5 + 14.7 = 19.7 pounds.

V = volume corresponding to pressure P or 25 feet.

V_1 = volume corresponding to pressure P_1.

Then $P\ V = P_1\ V_1$ or $14.7 \times 25 \div 19.7 = 18.6548$ feet, the length of the air column in pipe when gauge register 5 pounds. The original air column, 25 feet minus 18.6548 equals 6.3452 feet, which is the distance the water has risen inside the pipe. Therefore, 5 feet, the distance from bottom of tank to lower end of pipe, plus 6.3452 equals 11.3452, which is the distance from bottom of tank to level of water inside of pipe.

A column of water of one square inch cross section required to exert a pressure of 5 pounds equals $5 \div .434 = 11.5207$ feet, or the height of water in tank above level of water in pipe; this added to 11.3452 equals 22.8659 feet, the correct answer.

Boston, Mass. G. F. B.

EDITOR THE PRACTICAL ENGINEER:

It seems to me that since there are so many different answers to A. R. G.'s problem, it would be a good idea to reduce the matter to algebraic terms, which may be applied to any particular case by making the proper substitutions. This formula will be correct provided the effect of temperature, variation in barometric pressure, the correction for volume of gauge plug and pipe and the inaccuracy of the gauge itself, are neglected.

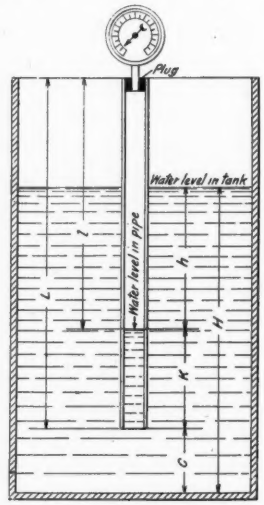
According to Boyle's law, $P \div P' = V \div V'$, in which P and V are original conditions of pressure and volume and P′ and V′ are the conditions after the water has been allowed to rise to a certain level, or since the pipe is of uniform internal area, we can substitute the length of pipe for volumes. If G equals gauge pressure then P = 14.7 and P′ = 14.7 + G, therefore

$$14.7 \div (14.7 + G) = l \div L$$

Now referring to the figure, we have L = total length of pipe, l = length of air space remaining after water has risen in pipe, h = head of water necessary to balance gauge pressure, K = distance water has risen in pipe = (L − l), C = distance between lower end of pipe and bottom of tank and H = C + K + h.

Since $l = \dfrac{14.7 \times L}{14.7 + G}$ and K = (L − l),

then $K = L - \dfrac{14.7 \times L}{14.7 + G}$, or $K = \dfrac{LG}{14.7 + G}$



Solution of A. R. G's Tank Problem

Now h, the head of water producing the gauge pressure is equal to G × 2.304, therefore H, which equals C + K + h becomes

$$H = \frac{LG}{14.7 + G} + 2.304\,G + C$$

and substituting the given values in A. R. G.'s problem, we have

$$H = \frac{25 \times 5}{19.7} + 2.304 \times 5 + 5 = 22.865 \text{ feet.}$$

Chicago, Ill. F. W. M.

EDITOR THE PRACTICAL ENGINEER:

In view of the many different answers to A. R. G.'s problem, I offer the following criticisms: In the first place there can be but one correct solution to this problem and in my opinion J. W.'s is the correct one. E. S. H. is to be commended for standing by his high school boys, but he should be more careful in adding. He states that 5 + 6.35 + 11.52 is equal to 26.87 when as a matter of fact, the way we add in New Haven it is equal to 22.87 feet, which is approximately the same as J. W.'s answer. Regarding C. J. Mason's solution, if he had read his article carefully, he would have discovered his error. He states that the head of water necessary to maintain a pressure of 5 pounds per square inch is 5 × .434 = 2.17 feet. Had he been familiar with the subject, he would have seen that this could not be correct. If he had divided 5 by .434 he would have 11.5 feet, which would give the right answer.

The other answers all disregard the air in the pipe, and.

therefore, must be incorrect, as the air in the pipe will be compressed to some extent and must be taken into consideration.

New Haven, Conn. H. J. R.

EDITOR THE PRACTICAL ENGINEER:

In your May issue, I see there are thirteen answers to my tank problem. The one from J. W., New Haven, Conn., 22.905 feet is right, according to his table of water pressures. C. J. Mason's demonstration is right, but he made a mistake in his last deduction; he should have divided by .434 instead of multiplied. E. S. H., of Louisville, Ky., is right in his solution, but he made a mistake in his final addition. When I gave the problem, I did not mean to infer that the high school boys did not know enough about mathematics to figure the problem, but not knowing the practical demonstration of it, they would fall into the same error that the other ten men, who answered the problem incorrectly, have done.

Middleboro, Mass. A. R. G.

EDITOR THE PRACTICAL ENGINEER:

In working out A. R. G.'s tank problem, there are a few things to consider which every engineer should know, namely:

1. Water is practically non-elastic.
2. Water at rest presses equally in every direction.
3. A given pressure exerted on any portion of a mass of water confined in a vessel is distributed equally through all parts of the mass.
4. The pressure on any particle of water is proportional to its depth below the surface.
5. Water always seeks to attain its own level.

In the problem, with 5 pounds gauge pressure above the water in the pipe, there must be $5 \div .434 = 11.52$ feet of water to balance the pressure. According to Mariotte's law, the pressure of any gas confined in a vessel rises in inverse proportion to its volume. We have in the pipe a mass of air 25 feet in height which must be compressed from 14.7 to 19.7 pounds absolute, so that we get the proportion

$$19.7 : 14.7 = 25 : x$$

$$\text{or } x = 18.654 \text{ feet.}$$

Since there are 18.654 feet of air over the water, there must be a column of 6.346 feet of water in the pipe. Therefore, we must have 5 feet from the bottom of the tank to the end of the pipe, 6.346 feet to balance the water in the pipe and 11.52 feet to balance the 5 pounds pressure, or $5 + 6.346 + 11.52 = 22.866$ feet.

Foxboro, Mass. C. J. S.

EDITOR THE PRACTICAL ENGINEER:

I notice in several solutions of the tank problem, that they are based on different assumptions. Now it appears to be understood that the system is empty to begin with. If water is run into the tank it will rise and at 5 feet from the bottom, it will seal the pipe. The water will continue to rise, according to the conditions of the problem, until the air in the pipe is compressed enough to raise the pressure to 5 pounds gauge, or 19.7 pounds absolute. The way to find out what length of pipe will contain air under the higher pressure is to multiply the original length of pipe by the atmospheric pressure of air and divide by the higher pressure, or $25 \times 14.7 \div 19.7 = 18.65$ so that there will be 6.35 feet of water in the pipe. As it takes 2.311 feet of water (slightly different values by different authorities) to create one pound pressure, the water must stand 5×2.311 higher outside the pipe than it stands inside, so that $5 + 6.35 + 11.555 = 22.905$ feet will be height of water, or 22.866 if 2.304 is used for the factor.

North Adams, Mass. T. H. R.

Mr. Mason Corrects Answer to A. R. G.'s Problem to 22.87 Feet.

EDITOR THE PRACTICAL ENGINEER:

In looking through the May issue, I discovered an error in my calculations relative to A. R. G.'s tank problem. Instead of multiplying 5 by the factor .434, I should have divided it by .434, which gives $5 \div .434 = 11.52$; or, by multiplying 5 by the factor 2.304 (some persons use 2.31), the same result will be obtained, or $5 \times 2.304 = 11.52$. This added to the 11.35 previously obtained equals 22.87, as the number of feet from the level of water in the tank to bottom of tank.

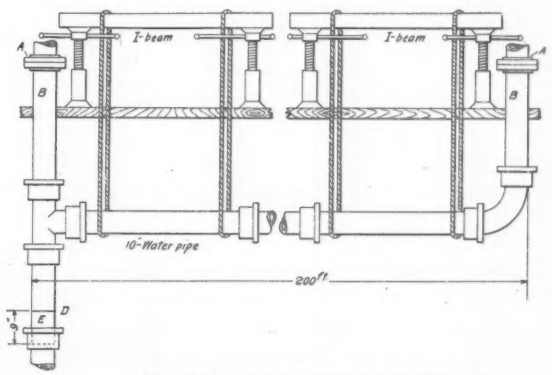
I wish to make this correction, as the result, 13.52, which appears in my letter, is incorrect and may cause unnecessary misunderstanding. The two constants, .434 and 2.304, which are concerned in this problem, were unthinkingly substituted for each, other so that the correct answer is 22.87 feet. Correspondent J. W., New Haven, Conn., gets 22.905, because he uses the factor 2.311 instead of 2.304. The difference is of no consequence, as the answers are sufficiently close for any practical purpose.

Scranton, Pa. CHAS. J. MASON.

Method Used for Lowering Water Pipe.

EDITOR THE PRACTICAL ENGINEER:

About six years ago I was employed at the works of the General Electric Co., at Peterboro, Canada, and while there, had occasion to lower a cast-iron city water piper, weighing about seven tons and 200 feet long. The following is a description of the method I employed without cutting the 200 foot length, which may interest some of the readers of THE PRACTICAL ENGINEER.



Method Used for Lowering Water Pipe

The pipe in question had to be lowered 9 inches, and as the water was constantly required, very little time could be spared for the operation. The two pieces B and B, shown in the accompanying sketch, were of wrought iron with the two

flanges screwed onto them. The rest of the pipe was heavy cast iron stock with leaded and caulked joints. First I had two nipples cut 9 inches long and a 10 inch coupling. Then I placed a number of jacks along the floor above the pipe, as the conditions were such as to prevent working at the pipes from underneath. Across every two jacks I placed an I beam and slung ropes as shown at K-K every 15 feet apart, and then had holes bored in the floor for the ropes to pass through.

When all preparations were completed I turned the water off and proceeded to cut the pipe apart at D. The flanges A and A were disconnected after chipping out the section shown at E, and by lowering the jacks about one inch at a time all along the line the pipe was lowered the desired 9 inches. I then supported the pipe properly in its new position and unscrewed the half-flanges at B and B, and put on the nipples and couplings and screwed the flanges on the upper thread of the nipple and made the connections.

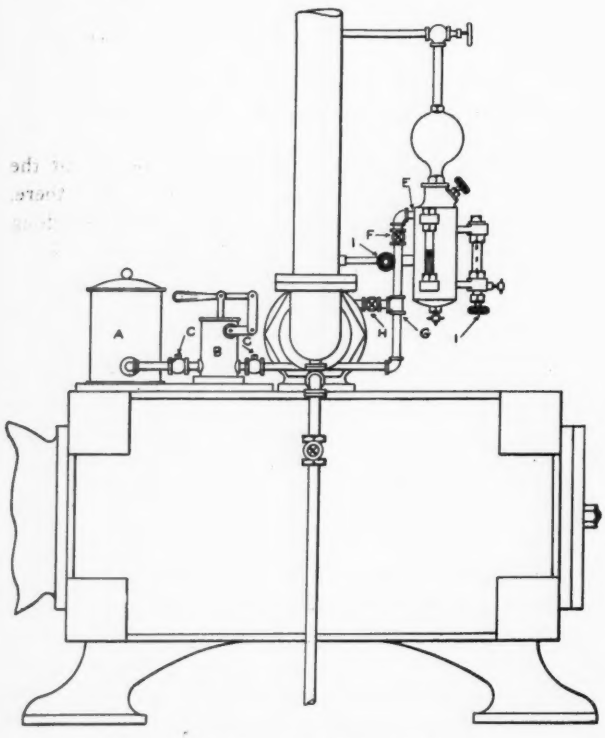
When the city pressure was turned on not one of the caulked joints leaked a drop, and the time occupied in doing the job was only a little over one and one-half hours.

Toronto, Canada. J. E. N.

Convenient Method for Filling Lubricator.

EDITOR THE PRACTICAL ENGINEER:

Reading in the March issue Scott's method of filling a lubricator, I thought perhaps your readers might be interested in reading of a method which I use and have found very satisfactory.



Convenient Method for Filling Lubricator

In the accompanying sketch, A is a small tank of about two gallons capacity, connected to a hand pump B, and both mounted on an oak board of suitable width and length. C-C are ¼-inch check valves, one being placed in the suction, and the other in the discharge of the pump. The pump I made myself, but, if desired, one can be purchased. The lubricator D is tapped at E for a ¼-inch pipe, and F is a ¼-inch valve. Connections may also be made to pump oil direct to the cylinder when desired, by tapping the throttle valve for a ¼-inch pipe and putting a tee in, as shown at G; H being a valve.

In filling, open angle valve F, and pump slowly. The oil coming down slowly forces the water up through the condensing chamber into the steam pipe, and then to the cylinder. There is no necessity to close the valves I-I, as the oil will be fed to the cylinder. The lubricator should never be filled so that the oil will be below the bottom of the indicating glass, as it may be pumped up through the condensing chamber. Valve F should be closed when pumping oil direct to the cylinder, and valve H should be open, but otherwise it should remain closed.

Should any of the readers of THE PRACTICAL ENGINEER desire to try this method, they will find it both convenient and economical, and save much time in filling.

Fertile, Minn. C. S.

Experience with a Cooling Tower.

EDITOR THE PRACTICAL ENGINEER:

Reading with much interest Dr. Harts' article, "Principles of Hygrometry," and your own very interesting remarks on "Removals of Little Drops of Water in the Atmosphere," especially that part relating to the superiority of atmospheric cooling towers over fan-operated ones, reminds me of a very interesting and valuable experience in the construction and operation of a hurriedly built cooling tower, at a Louisiana sugar house, some years ago.

By way of explanation of the circumstances which occasioned the necessity of the cooling tower, I would state that the sugar house was of six hundred tons cane milling capacity. We should have had, for good work, and for all purposes, about one and one-half gallons of water per minute for each ton of cane milled per twenty-four hours, making our total requirements about nine hundred gallons per minute. Of this amount the jet condensers attached to the sugar or finishing vacuum pan, and the second or syrup (vacuum) pan of the "double effect" juice evaporating apparatus, needed six hundred gallons. We had two 8-inch wells, about one hundred and eighty feet deep, with only twenty lineal feet each of screen. These wells, at the beginning of the season, were delivering only about eight hundrd gallons per minute. The deficiency was made up by circulating the water from condenser wells about the place in ditches, and drawing into these ditches such quantity as was necessary to keep the storage pond supply up. From this pond the water was pumped into tanks near the condensers, and from these tanks they drew their supply by the vacuum in the condensers. The waste, or once-used water from the condensers, escaped through the condenser well pipes into a well whose overflow was sufficiently high to seal the mouth of these 8-inch tubes. The condensers were placed over thirty feet above the well. The season, October, was a dry one, and quite warm. The wells were located about a thousand feet from the Mississippi River, which had then fallen to a point about twenty-five feet below the ground level at the wells. Our local weather does not affect the Missippi River, but does very seriously affect the height of the water in wells adjacent to the river. The

dry season permitted the standing height of the water in the wells to pretty closely follow down to the river water level. Each well was served by its own pump, each pump being of about six hundred gallons capacity per minute. These pumps were located in cement pits, five feet below the surface of the ground, to dimish the lift.

For reasons not necessary to detail, the well output decreased to five hundred gallons per minute. This required a greater portion to be added from the warm waste water from the condenser, raising the temperature of the injection water at the condensers. Some means had to be devised for cooling the re-used water better than its circulation in ditches three thousand feet long, as the ground was warm. The evaporation was considerable, the absorption by the ground during the dry weather was increasing, and everything was against such a convenient but poor method of cooling.

In this emergency I was governed chiefly by considerations of ease and rapidity of construction, and of moderation of cost, as it was to be used only a few weeks to terminate the season, when we expected to go more radically about an increased primary water supply for succeeding seasons.

The first plan that suggested itself to me was a tower twelve feet square at the bottom, six feet square at the top, and as high as posts twenty-four feet long would make it. I nailed beveled slats around the tower at an angle like half-rolled venetian blinds, the different bands of slats being placed about ten inches between centers. The slats had one corner curved bevel, which made the angle of inclination of the shelves nearly forty-five degrees. The whole center was clear, a platform on top, or a fairly solid top on which I could pump the water and have it flow down the sides of the tower, which was located on the bank of our storage pond. With a lot of second hand 8-inch cast iron pipe, I made connections through the ground and up to the top of the tower. We had a Cameron fly wheel-vacuum pump on our sugar pan, and a Worthington duplex directing vacuum pump on the second pan of the "double effect." An extra Knowles 16" x 18" x 24" direct acting vacuum pump was coupled to relieve either the others in case of an emergency. The suction, or air, pipe of this pump was disconnected and switched into the condenser well. A float was placed in the well attached to a butterfly valve placed in the steam pipe of this pump, to control its movement, and keep it from exhausting the well below the openings in the condenser well pipes, which would break the vacuum in the pan or "effect."

Inside of twenty-four hours we were ready to start, but the capacity of my pump, with the cylinder 18-inches diameter, was so great that, being controlled by my float, there were long pauses at each end of each stroke, and, therefore, a lack of continuity of flow down the sides of the tower. To overcome this, I placed a hogshead, bored full of small holes, on top of the tower, into which the pump was discharged, which caused a perfectly continuous flow.

The results obtained from this tower were six hundred gallons of water per minute, reduced from a temperature of 120° F., to uniformly three degrees below the temperature of the atmosphere, at such times as temperatures were taken. The average atmospheric temperature for the first few days was eighty, when the water would go down from seventy-seven to sixty-seven at night. The temperature of the condenser well varied frequently, due to the amount of evaporation going on, or the quantity of injector water being used, but it did not vary much. Here was a highly efficient tower, based on an enormous surface of water, exposed to fresh air.

In the above instance it is of interest to note that the entire water evaporation from the sugar solutions under treatment, approximately two thousand gallons per hour, was added to the sum total of our water. However, it appeared that there was, at least, the equivalent of this lost about the tower, to which was added the invisible amount that was completing the saturation of the air that came in contact with the water.

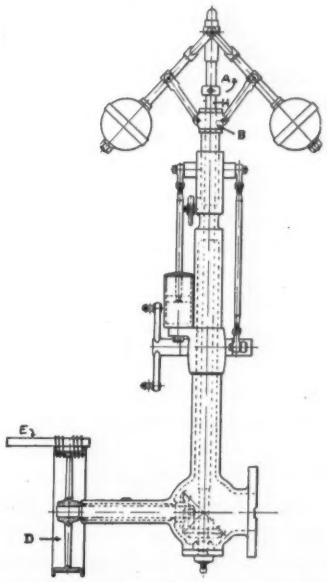
I have no doubt many of the readers of this article are familiar with fan cooling towers, of which no criticism is intended; however, others in a like emergency may find the above experience a valuable aid in solving their difficulties.

New Orleans, La. ALLAHASSETT.

How to Find the Speed of an Engine When the Plant is Shut Down.

EDITOR THE PRACTICAL ENGINEER:

On page 26 of the March issue, a writer, T. S., tells of a question that was asked him by an examiner in Massachusetts pertaining to the method of finding the speed of an engine when the plant was shut down. In reference to this question, I should say that what the examiner meant was "Could T. S. find out about what speed the engine would run without light-



How to Find Speed of Engine from the Governor

ing fires under his boilers and getting up steam to run the engine." Such a thing is possible, and an engineer can come pretty close to finding at what speed the engine had run before the plant was shut down, and I will, therefore, offer a few suggestions for the benefit of T. S.

Assuming that the governor is of the fly ball type, measure the distance between the stop collar A on the vertical revolving shaft, and the top of the sliding sleeve B. Examine the revolving shaft closely, about one-half the distance between A and B, and see if there is a bright ring around the shaft where B had been revolving; if there is, that is the height or plane the

governor had been working when the engine was running. If the engine was new and had not been run, I should make a mark about five-eighths of the distance between A and B, as at H, and then proceed to try this experiment:

Take the belt off governor pulley D and fasten to the pulley with stout twine a piece of broom handle about 12 inches long, as at E. Put the wrist plate on center marks so that there will be no interference with knock-off knuckles; then turn the governor pulley by hand until the sleeve B will rise to H. Count the number of turns made by D per minute to keep collar H at this point. Multiply that number of turns by the diameter of the pulley D in inches, and divide the result by the diameter of the pulley on the crank shaft; the quotient will be the number of revolutions that the engine will run, or very close to it. If T. S. ever tries this method, the writer would be pleased to hear the result through these columns.

Fall River, Mass. M. H. H.

Advice About Taking Charge of a Steam Plant.

EDITOR THE PRACTICAL ENGINEER:

When I read your interesting editorial in the December issue, which is one that no engineer can afford to overlook, whether he is on the verge of taking charge of a new plant or not, I remembered the time when I took charge of my first plant. Like any other ambitious, but inexperienced youth, I thought I knew the whole of engineering, from alpha to omega; however, I condescended to listen to a few practical pointers from an old timer. Since that time, experience has demonstrated the truth of what he said, and I think the same advice, perhaps, would benefit some young readers of THE PRACTICAL ENGINEER, who are about to take charge of a steam plant for the first time.

As near as I can recall it, the advice I was given was as follows: "First of all, my boy, whatever happens, do not allow yourself to get excited and lose your bearings, or at least, do not show it; but keep your own counsel and look wise. There is generally time to do a little reasoning as to cause and effect, and in the end it will save you time and extra work, and keep you from making a fool of yourself in the eyes of others. If the plant is a new one, you will in all probability get necessary information from the erector, in whose interest it is that everything should turn out right. If, on the other hand, the plant has been running some time, you are up against two propositions: either your predecessor leaves for a better situation, or he is discharged. In the former case you will get all the necessary information from him before he leaves, but the latter case is where you have to rely on your own experience, and what you have learned from the experience of others. As a rule, you do not need to worry much about spite work; engineers, as a class, are above such a thing; but whether discharged justly or unjustly, a man is not likely to give his successor too much advice about the plant, and you can hardly blame him. So, unless the whole crew should quit in sympathy with the chief, the chances are that the plant will keep on running for a day or two, as if your presence was not needed; a fact you will heed if you are wise.

"No matter how well posted you may think you are, the men already working in the place know more about its details than you do, and it is better to lay low for a few days while you are getting posted instead of showing any real or imaginary importance, which will only make you ridiculous in their eyes, at a time when you can least afford it.

"While making yourself familiar with the surroundings, it is well to bear in mind that the man who laid out and installed the plant probably knew as much about steam engineering as you do, and if you find things wrong, the cause of it can very likely be traced to ignorance or neglect on the part of attendants. Here is where you earn some of your salary in remedying such troubles. There are plants laid out by architects and consulting engineers which could be improved upon by a practical stationary engineer, and yours may be one of them. However, do the best you can with what you have for the present, as your employer is not likely to listen to any talk about changes that will incur considerable expense, until you have shown by your work that you really know your business, and that money spent on improvements will prove a good investment."

Even if a young man had a lifetime of experience when he takes charge of his first plant, he will run up against propositions that will keep him guessing. A steam plant equipment differs so widely these days, in fact, stationary engineering includes so many trades, that, unless a man makes good use of others' experience, as well as his own, he will often find himself in a tight place.

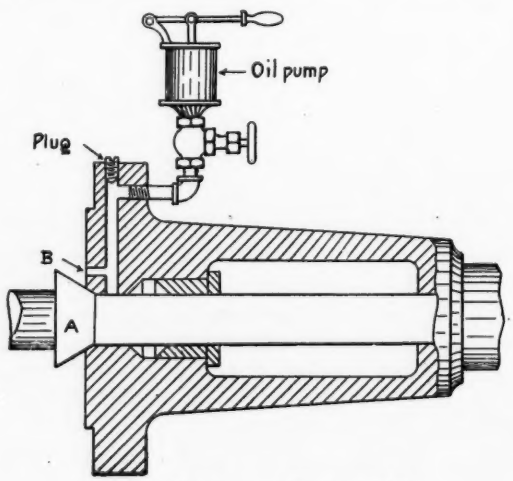
The best way to get this knowledge is to read the trade journals, and the popularity of the letter columns of THE PRACTICAL ENGINEER seems to indicate that such is the opinion of others besides that of the writer.

Chicago, Ill. R. C.

Remedy for Valve Stem Trouble.

EDITOR THE PRACTICAL ENGINEER:

Some time ago I noticed that an engineer wanted to know how to prevent the wearing out of collars on the bonnets



Remedy for Valve Stem Trouble

of his engine. The following is an idea of mine that is in use every day, and giving the best of results: The bonnet is drilled with a 5/16-inch hole to the valve stem; then plug up the top of the hole, and come out on the side with a

nipple and an ell. This oils the valve stem and at the same time the oil runs along to the metallic packing. Some of our stems have a cone bearing inside of the bonnet, as at A. The hole is not drilled through, but comes out inside at B, which is a 3/16-inch hole. The oil drops down on the cone, and the amount of oil necessary depends upon experience. We feed oil about every two or three hours.

St. Louis, Mo. F. J. W.

Catalogue Information. Value of Books. Vacuum in an Injector.

EDITOR THE PRACTICAL ENGINEER:

It is certainly a lively discussion that is going on in your columns anent catalogue information, etc. Golden West seems to be getting a few hard raps, but certainly no more than I thought he would get when I saw his letter. I had the misfortune yesterday to come in contact with a man of this type (there are not many), who seemed to think you were not doing exactly the right thing if you addressed him in a polite manner. From all indications you would think he was afflicted with chronic dyspepsia if his robust size did not prove the contrary. I dropped into the engine room to see him on business, and being told that he was the engineer of the place, gave him a pleasant "good afternoon," to which he snorted out a kind of "hugh." I then said: "I believe you are the engineer in charge," and he, seeming to think I was looking for the consulting engineer of the job, said, "No!" I thought to myself, "No, nor likely to be," and then said to him that I understood that he was the man in charge of the operating department, and he gave me to understand that he "was one of the engineers." In short, the scene was one of effectation, and I saw that he cared little for his reputation as a man and that he had nothing of that appreciation of human nature that denotes the great man. Apparently he hated himself and tried to take his spleen out on those around him, for I noticed that he had not a pleasant word for anyone around the plant. It was "git out of here" and "git at that" for the whole of the two hours that I spent in the plant. A cordial German in charge of the stokers and a witty Irish oiler seemed to be decidedly better satisfied when he was out of sight and hearing. Time seemed to hang on his hands, for he did not seem to be particularly occupied with anything.

After finding him out, I ignored his existence, and this caused him to stand around wherever I went with an air of offended dignity and neglected importance. From what I gathered in conversation with the men, it would seem that this particular man, who had a scraggly red mustache, is of the "walking-delegate-frequent-change-no-satisfied" type that is always able to be "chief," but that somehow never seems to be recognized as to ability. Men of this type automatically place themselves on the defensive and seem to be afraid that some one will injure them, little realizing that at best the defense is the weakest side of the case and must be handled with the greatest care. How much easier life would be for themselves and those around if they could get rid of the idea that every one is trying to hurt their precious reputations, and quit their snarling and fussing way of talking while at the same time leaving carping criticism aside.

As to the value of catalogues, there is hardly an engineer in consulting work that could get along without his catalogue file. If men who have had the theoretical training need the catalogues, yes, and the ads., what shall we say of those who know nothing of the subject. I would say to all catalogue students, get all you can out of the catalogue, but remember at the same time that it is the organ of the manufacturer, and he may be depended on to grind his own axe on his own stone in his own way. Thus it will not do to swallow everything as gospel truth, but rather choke it down as a child takes medicine, so that you may be sure of weeding out the sophistries and leaving nothing to be digested but the genuine information.

Right here it is well to say that books are no more to be taken as authority than are other things. While a book does not grind any particular axe, it nevertheless harps on what is the author's opinion and discusses things from his viewpoint, and his viewpoint may be in China, whereas you want to be in the United States. All books contain errors that are more or less vital and, where there are no positive errors, there are numerous misleading statements. It is only by reading and studying the same thing by different authors that we can finally get on sure ground. While this reading is being done, one may as well as not take in all the information that can be gotten from the catalogues.

C. J. W. gives an interesting letter on page 29 of the March number regarding the vacuum in an injector, and I think that he is right about its being a tendency to form a vacuum rather than the actual presence of a void space in some part of the injector's anatomy. This, I believe, is the idea by all those engineers who give any thought to the subject and the matter of breaking the vacuum is rather the removing of the cause that tends to create a vacuum rather than the actual filling of empty or partially empty space, as where the vacuum is broken on a jet condenser. Common parlance, however, does not take account of these refinements, and the ordinary engineer is satisfied to say that the vacuum is broken, believing that refinements of expression are necessary only in metaphysics and other such realms where there is grave danger of trying to express something that no one can understand.

E. S. HAWKINS.

Good Boiler Performance.

EDITOR THE PRACTICAL ENGINEER:

We read of the rated horse power of boilers of over-worked boilers and of boilers being rushed, but I have seen a plant consisting of two horizontal return tubular boilers 72" x 16' with 82 4-inch tubes, each rated at 125 horse power by the builders, which furnish steam for two engines from which cards have been taken showing 510 indicated horse power besides furnishing live steam used for heating and other purposes in the factory.

These boilers have been evaporating 2,000 gallons of water per hour, 10 hours per day for the past three months, and did not seem to be worked hard. The steam pressure never varied over 3 or 4 pounds and the damper is closed or partly closed about 2/3 of the time. This may be nothing unusual, but I think it is.

Winooski, Vt. M. T. M.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

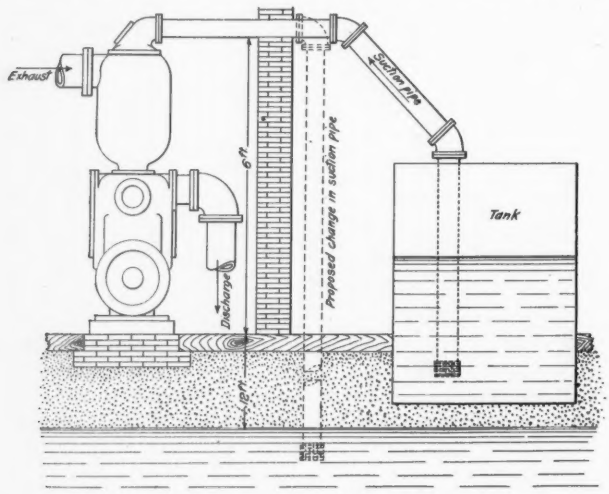
To Our Readers.

As a number of letters, without any names or addresses, have been received recently, we would like to call the attention of our readers to the fact that all letters addressed to the Editor should be accompanied by the name and address of the writer, if a reply is desired.

Which Arrangement of Suction Pipe is Better?

EDITOR THE PRACTICAL ENGINEER:

I am running a cross-compound condensing engine in connection with a water-wheel. The engine room is situated about ten feet below the dam and the level of the water in the wheel pit is about 12 feet below the engine room floor. Our condenser is on a level with the engine cylinder and takes its water from a tank supplied by gravity from the dam. I suggested to



Which Arrangement of Suction Pipe is Better?

the chief to run the suction of the condenser pump into the wheel pit and get the tank out of the way. We would also thus get clean water, as the rack prevents leaves and small sticks from going through them. This foreign matter causes lots of trouble, as it keeps our condenser blocked either at the condenser or at the screen on the pipe at the dam.

The chief told me to suggest something that would cut down the steam consumption, not increase it, as the condenser was using enough now. I argued that it would take no more steam to bring the water out of the pit than was used under present conditions, provided he increased the size of the suction pipe an inch or so, as we carry 26 inches vacuum. I cannot see why the water will not come to the pump from the pit, just as well as from the tank without the expenditure of any more power. Now I think I am right, and I would like to hear from some of the readers of THE PRACTICAL ENGINEER about it.

Adams, Mass. T. S.

Why Does Not the Generator Compound?

EDITOR THE PRACTICAL ENGINEER:

I am operating two 200 K. W., 335 ampere, 600 volt compound direct current generators for street car service. Each generator is direct connected to an automatic engine of same make, size and speed. One generator will compound very nicely, the other will not, even when the series shunt strip is open. The machines are operated in parallel six hours a day, and the balance of the time singly. No connections on the machine have been changed and the load varies from zero to 500 amperes.

I would like to know why one machine will not compound as well as formerly or as well as the other machine—its exact duplicate. If some of your readers can enlighten me, I will try and return the compliment some time.

Morgantown, W. Va. C. E. N.

Butt-Joints. Upright Boiler. Fly-Wheel Governor. Setting Corliss Valves.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following questions as soon as convenient?

1. Why are butt strap joints stronger than lap-joints, both being triple riveted?

2. Why can an upright boiler be constructed to carry more pressure than a horizontal boiler?

3. Why is the bottom end of a Manning boiler made larger than the top?

4. How does the fly-wheel governor act on the valve to cut off the steam?

5. How would you set a Corliss valve when everything is disconnected?

6. When everything was connected and one valve was a little out, how would you adjust it?

New Bedford, Mass. B. A. L.

1. A butt-joint is stronger than a lap-joint because the pull of the joint is in the direction of the centre of the plates, and also because the rivets are in double instead of single shear.

2. Horizontal boilers can be made to carry pressures as high as vertical boilers are capable of carrying. Vertical boilers are generally supposed to be able to carry higher pressures, but this is probably due to the fact that they are made more generally in small diameters. For a given construction, the larger the diameter of a boiler, the less pressure it can carry.

3. Manning boilers are made larger at the bottom to accommodate the fire box. In this type of boiler, due to this construction, the proportion of grate area to heating surface can be made so that the most economical evaporative efficiency can be attained. This makes the fire-box larger than is common with vertical tubular boiler construction.

4. The methods used to change the point of cut-off when fly-wheel governors are used differ widely, but the result is the same in each case. Of the three types of governors in

use, some depend upon centrifugal force being balanced by springs, another type depends upon the action of inertia on the governor weight, and the third type depends upon the combination of the inertia and centrifugal types. In some forms of governors the lead changes with the cut-off, by changing either the angle of advance or the eccentricity, but in most modern governors both are changed so that a variable cut-off

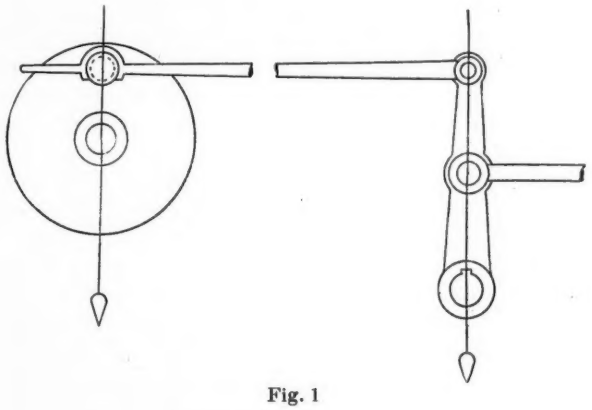


Fig. 1

with a nearly constant lead is attained. In every governor the weights are moved as the speed increases, and by its own peculiar mechanism moves the valve and regulates the supply of steam to the cylinder, thus continually balancing the internal forces and the external effort.

5. Connect up the different parts and equalize their movements. Place the wrist plate and rocker arm as shown in Fig. 1, and with a straight-edge and scriber mark the position of the wrist-plate as at *a* and *b*, Fig. 2. Turn the eccentric on the shaft to the dead centre and make a mark *c* to correspond to line *a* on the wrist-plate. Turn the eccentric to the other centre and in the same manner mark *d*. Then the mark *b* should be equally distant from *d* on one side as it is from *c* on the other. If the mark *d* is nearer *b* than the mark *c*, then the eccentric rod must be lengthened or so adjusted that mark *b* will be exactly between *c* and *d*, which proves that the eccentric rod is the proper length. When *d* and *c* are found to be correct, they should be made permanent marks.

The lap of the steam valves should next be utilized. Remove the valve chest covers so that the ends of the valves will be in plain sight, as shown in Fig. 3. Three marks are usually visible which have been placed there by the engine builders, as *m*, *o* and *r*. The mark *m* represents the working edge of the valve, *o* the edge of the steam port, and the distance between

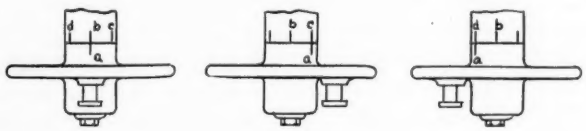


Fig. 2

marks *o* and *r* represents the amount the valve should lap over the edge of the port when the wrist-plate is plumb, the hooks engaging both catch blocks. Now raise the governor and insert the safety-stop, and after setting the wrist-plate plumb by means of marks *a* and *b* and being sure the hooks have raised the crank-arms on the stems, the lines *m* and *r* should be exactly in line with each other. If the valves have not the proper lap, the radial rods connected to the wrist-plate should be so adjusted until *m* and *r* do coincide.

The wrist-plate should now be turned so that the lines *a* and *c* on the hub, as shown in Fig. 2, coincide. Then adjust the length of the dashpot-rod until the clearance spaces *s* and *f*, shown in Fig. 4, are obtained. Then turn the wrist-plate to the opposite extreme position so that *a* and *d* coincide. Adjust the dashpot at that end of the cylinder so that the proper clearance at *s* and *t* is obtained. Now, hook the reach rod on the wrist-plate and turn the eccentrics to one of the extreme positions so that the lines on the wrist-plate and hub nearly coincide.

The valve now being open, the length of the governor rod should be adjusted so that the inner member of the hook just engages the projection of the knock-off cam. Move the wrist-plate by turning the eccentric until the lines on the hub coincide. The valve which has been raised should now be released and the dashpot plunger properly seated.

The governor rod should be so adjusted that the steam valve will be released by the time the wrist-plate reaches the extreme position in order to insure the valve being closed when the latest point of cut-off is reached, which point corresponds to the extreme position of the wrist-plate and eccentric with the governor in its lowest position; that is, when the collar or sleeve is resting on the safety stop. The governor rod on the opposite end should be similarly adjusted.

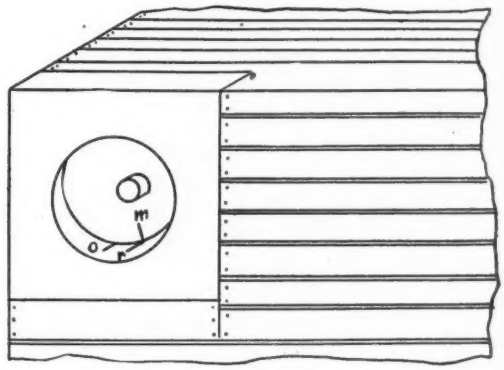


Fig. 3

When adjusting the lap of the steam valves on double-eccentric engines, the valves have no lap as they do on single eccentric engines, and it is therefore important to see that the valve arms are released from the hooks by the time the eccentric and wrist-plate reach the extreme positions, otherwise when the wrist-plate reaches its central position both ports will be open at the same time, which condition will result in live steam flowing directly into the exhaust pipe, causing a considerable waste of steam.

When setting the eccentric, it is first necessary to observe the style of wrist-plate operating the steam valves. If the wrist-plate is of the style having nearly vertical radial rods, it will be seen that when the eccentric moves away from the cylinder, the hook corresponding to the head-end valve will be moving in the opposite direction to that required to open the valve; consequently, the eccentric in this case must be moved

around in the opposite direction to that in which the valve is to turn, when giving the valve lead. When the wrist-plate is similar to those employed on single-eccentric engines, the eccentric is turned in the same direction that the crank is turned.

To set the eccentric, place the full side of the eccentric on the dead centre nearest the cylinder, if the head-end valve is to be set first, and drop the reach rod on the stud in the wrist-plate. Turn the eccentric around on the shaft usually in the direction in which the engine is to run, and until the valve at the head-end of the cylinder has opened the port to the amount of lead, which will be indicated by the position of the lines *m* and *o* in Fig. 3. Tighten the set screws on the eccentric and have the crank turned to the opposite dead centre and examine the lead on the other steam valve. If it is not the same, adjust the wrist-plate connection, being sure that there still remains the proper clearance space *s* and *t* in Fig. 4.

Before setting the exhaust valves, the amount of compression should be known, which can best be found by trial. When the piston is within about two or two and one-half inches of the end of the stroke, it is a good place to have the exhaust valve closed. To do this, turn the engine until it is about the required distance from the end of the stroke and turn the exhaust eccentric so that the mark on the valve will indicate that

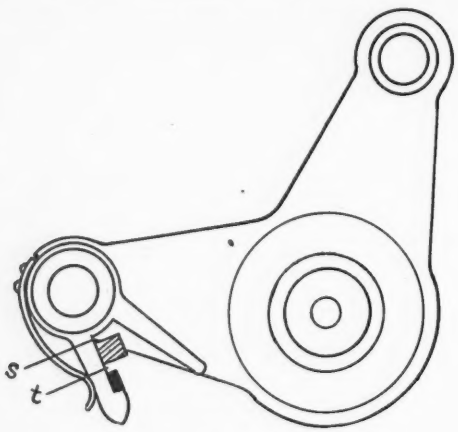


Fig. 4

the port is just closed. When the engine is the required distance from the other centre, the other exhaust valve should be set in the same manner.

The governor must then be adjusted to give an equal cut-off on each end of the cylinder. As all Corliss engine governors are equipped with some form of stop device which cuts steam off the cylinder, and as this stop determines the lowest position of the governor at which the valves should hook on, it should be kept in place while the adjustments are being made. Then unhook the reach-rod from the wrist-plate, and by means of the starting bar move the wrist-plate over until the lines *a* and *c* in Fig. 2 are nearly opposite each other. The head-end valve should now have opened the port to nearly the limit, which may be ascertained by the marks on the valve. Adjust the governor-rod so that the projection on the disc operated by the governor will come into contact with the inner member of the hook and so that the valve will be tripped or released when the marks *a* and *c* are exactly in line. As all governors do not move an equal amount to produce a given change in the point of cut-off, it is better to hook the reach-rod on the wrist-plate and have the engine turned in the direction it is to run, until the head-end valve is released, than to adjust the cut-off with the use of the starting bar. Measure the distance the piston has moved in the forward stroke when the steam valve closes and lay off the same distance from the crank end on the crosshead guide. Turn the crank in the same direction until the crosshead nearly reaches the mark on the guide and unhook the reach-rod and turn the wrist-plate around until the marks *a* and *d* are nearly opposite each other. Adjust the length of the rod from the governor until the projection of the disc operated by the governor comes into contact with the inner member of the hook, so that the valve will be released when the crosshead reaches the mark on the crosshead guide referred to, and the marks *a* and *d* are exactly in line. Both valves will then cut-off at the same point in the forward and return strokes.

Many engineers prefer to adjust the cut-off at about the average point when running under load, in which case the governor must be raised until the cut-off occurs at this point. If a more accurate adjustment is required, the use of the indicator will indicate more exactly how the cut-off should be adjusted. The valve-chest covers can now be put on, when the work of setting and adjusting the valves will be completed.

6. Adjust the link connecting the wrist-plate to the valve.—[Ed.]

Speed of Pulley. Strength of Wire Rope.

Editor The Practical Engineer:

Kindly answer in the next issue, the following questions:

1. The belt wheel on a dynamo is 2 feet and runs at a speed of 600 revolutions per minute; the belt wheel on the engine is 14.5 feet in diameter. At what speed must the engine run?

2. Give the breaking strain of a $^{11}/_{16}$-inch steel wire rope; also safe working load. E. E. H.

Cable, Ill.

1. Assuming that there is no belt slip, the engine should run at 82.75 revolutions per minute.

2. The breaking strain of a steel rope of this diameter is 31,600 pounds, and, allowing a factor of safety of 6, the safe working load would be 5266 pounds.

Changing Length of Eccentric Rod.

Editor The Practical Engineer:

Please answer this question in your next paper: What effect would be produced upon the lap and lead by changing the length of the eccentric rod? J. B.

Huntingdon Beach, Cal.

Assuming that the valve is properly designed and that the eccentric rod is of proper length, the effect of changing the length of the eccentric rod would be to distort the points of cut-off, release, compression and admission in both ends of the cylinder. The lengthening or shortening the eccentric rod has the effect of throwing the valve out of the central position and makes the point of cut-off, release, compression and admission occur too late on one end of the cylinder and to early on the other.

Locomotives equipped with feed water heaters have recently been put in service on the Egyptian State railways, and they are said to effect a saving in coal consumed of 21.4 per cent.

Hoppes Feed-Water Heater and Purifier.

The accompanying illustrations show some of the recent improvements of the Hoppes class "R" open feed water heaters. Fig. 1 is a side view of the heater, showing the arrangement of pans and the oil catcher, while Fig. 2 is an end sectional view, showing the delivery of the water to the feed troughs and pans. The shell of the heater is cylindrical and the heads are "bumped," a design calculated to resist pressure and also to prevent pulsations, due to the impulses of the exhaust.

The heater shown is 10,000 horse power capacity, and is provided with four double tiers of multi trough-shaped pans. The feed-troughs, pans and bottom of heater are made of cast-iron to resist corrosion, and the same heater is built in what the manufacturers call Class "T" type, in which the entire shell is made of cast-iron.

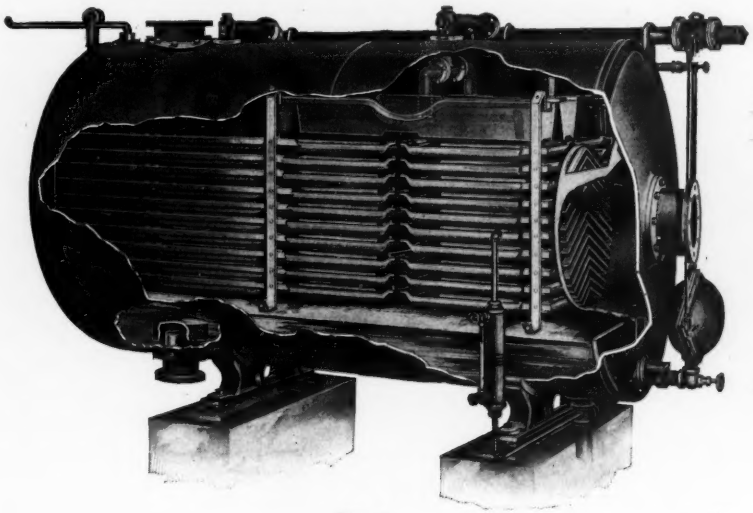


Fig. 1

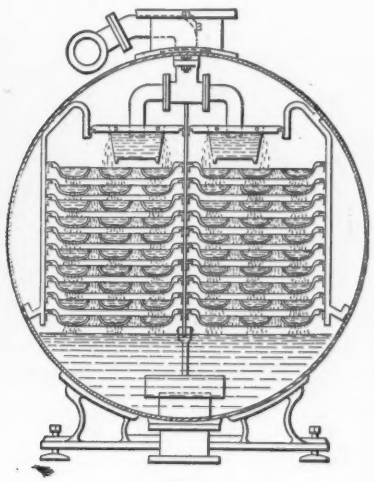


Fig. 2

The normal storage of water in the bottom of the heater is shown in the end sectional view, but where more storage is required, several layers of the bottom pans are left out and the maximum water line is fixed at the centre of the shell by raising the overflow dam. This dam is shown at the rear end and controls the overflow and acts as a skimmer for same. The overflow pipe is attached near the bottom of the back head. The water is admitted to the heater by a balanced regulating valve and regulated by a float in a separate float chamber.

In operation, the water is delivered into the feed-troughs through the feed-pipe, shown at the top, and is evenly distributed by means of discs having uniform openings placed between the flanges of the tees in the feed-pipe and the L-shaped connections extending down into the feed-troughs. The water overflows from the troughs into the pans and overflowing the sides, it follows along the under side of the pans in a thin film to the centre of each trough before dropping down into the next pans. While following the under side of the pans, the exhaust steam will come in contact with the water and heat it to the temperature of the exhaust. All the solids which may be held in solution in the water will, when liberated by the heat, form mostly on the under side of the pans, while matter in suspension will be deposited inside of the pans. As the water continues to follow the under side of the pans or the lime already formed, the full efficiency of the machine is realized until ready to clean. The oil catcher provided is very large and efficient.

In open heaters of large size the regulation and distribution of the water is a very important matter, as to be effective, the steam should come in direct contact with the water, and to do this the passage of the water should be gentle and as free from agitation as possible. The principle of flowing the water evenly over the under side of the pans in these heaters brings this about in a practical manner.

By the use of the artificial regulation provided in this heater, the water is not only evenly distributed to the pans, but two or more heaters may be used in multiple by providing a single regulating valve in the main feed-pipe controlled by a float attached to an equalizing pipe at the bottom.

Heaters of this type are built in sizes ranging from 50 to 32,000 H. H., and are manufactured by the Hoppes Manufacturing Company, Springfield, Ohio.

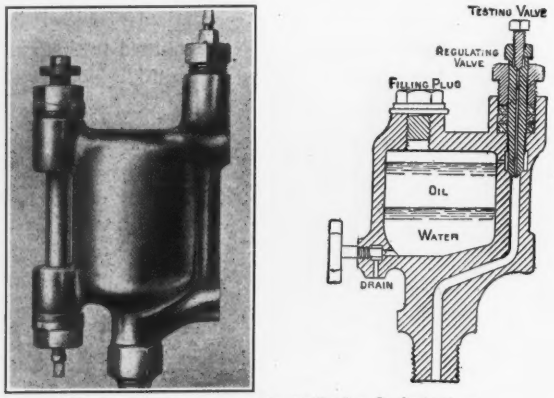
The Leyland Automatic Cylinder Lubricator.

The Leyland automatic oil cup is designed and constructed to give an automatic and controlable feed of lubricant to the cylinders of steam engines, with no more attention in operation and scarcely any more complexity in construction than an ordinary bearing cup. The radical difference between it and an oil cup is that is discharges at the top instead of the bottom, the oil being conveyed to the screwed connection by a passage at the side, as shown in the sectional view. A drip valve is placed at the bottom and a filling plug replaces the usual cover of the oil cup.

The automatic cup is attached to the steam chest or to the pipe below the throttle valve. When steam is admitted it passes up the cored passage at the side into the space on top of the oil, and, condensing, settles through the oil, raising the level of the latter, so that it passes out and follows down the same passage by which the steam enters. This action is intensified by the fluctuating pressure due to the intermittent demand of the cylinder, a positive outflow from the cup being ocasioned each time that the pressure in the side passage is reduced by the opening of the admission valve.

The regulating valve being once set at the point which will give the required feed, the cup requires no further attention and will feed a little oil every time the engine takes steam and stop feeding when the steam is shut off. When the oil has all been used, the regulating valve is closed, the filling plug removed, the drain opened and the water allowed to escape, when the cup is refilled with oil and put back into service.

The body of the oil cup, being directly attached to the hot chest or pipe, assumes a temperature which keeps its contents

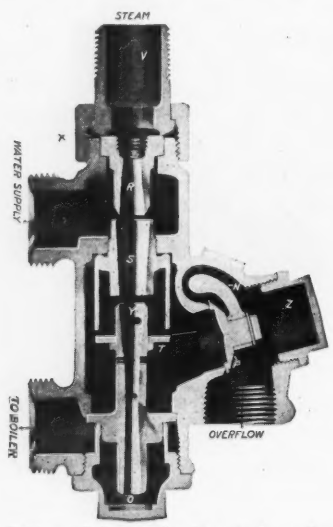


The Leyland Automatic Cylinder Lubricator

at a consistency that enables it to handle not only heavy oils, but greases. It is made of both brass and cast-iron, with or without glass gauge, by the Empire State Engineering Co., 149 Broadway, New York City.

The Penberthy Automatic Injector.

The Penberthy automatic injector, a sectional view of which is shown in the accompanying illustration, possesses, besides the other well-known advantages of the injector, the automatic quality of restarting by means of which, should the current of water be broken or be suddenly interrupted from any cause,



Sectional View of the Penberthy Automatic Injector

the injector will pick up the water and again establish the current to the boiler automatically without the manipulation of a single valve or attention form the attendant. It is constructed so as to have few wearing parts, but should renewals be necessary, all parts are interchangeable when required.

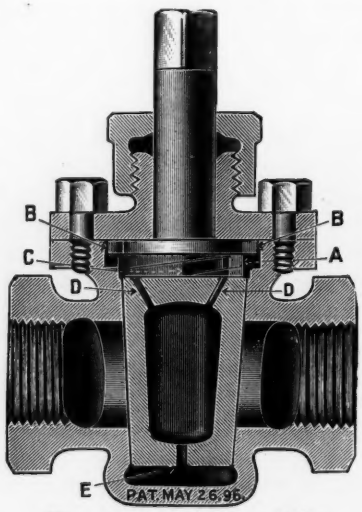
Its operation is as follows: Steam discharges from the nozzle R, flows through the larger opening at the mouth of the suction tube S, and raises the water to the feed chamber. The partial vacuum, caused by the condensation of the steam, raises the washer T to its seat in the combining tube, so that no air can enter the injector, even if water valve P should leak. Water is delivered to the boiler at a temperature of from 160 to 212 degrees, depending upon the temperature of the feed water and steam pressure, the higher temperatures being obtained by throttling the suction valve and delivering the minimum capacity.

The Penberthy Injector Co., of Detroit, Mich., are the manufacturers.

The Homestead Straightway Valve.

A valve, which within the past few years has been widely used in many lines of work, is the Homestead straightway valve, a sectional view of which is shown herewith. As will be noticed, when the pressure passes through it, the seat is protected from wear and it is so constructed that when it is closed it is at the same time forced firmly on its seat. This result is secured by means of the travelling cam, A, though which the stem passes. The cam is prevented from turning with the stem by means of the lugs, B, which move vertically in slots.

When the valve is open, the cam will be in the lower part



Homestead Straightway Valve

of the chamber in which it is placed, and the plug will be free to be easily moved. A quarter of a turn in the direction for closing causes the cam to rise and take a bearing on the upper surface of the chamber, and the only effect of further effort to turn the stem in that direction is to force the plug more firmly to the seat. A slight motion in the other direction immediately releases the cam and the plug turns easily, being arrested at its proper open position by contact of the fingers of the cam at the other end of its travel. E and D, D, are balancing ports which allow the pressure to be exerted at the top of the valve, thus holding it in its seat when the valve is open.

This valve is made in all sizes up to 6 inches, for all pressures up to 5,000 pounds, and is also made in 3-way and 4-way patterns. The Homestead Valve Manufacturing Co., of Pittsburg, Pa., are the manufacturers.

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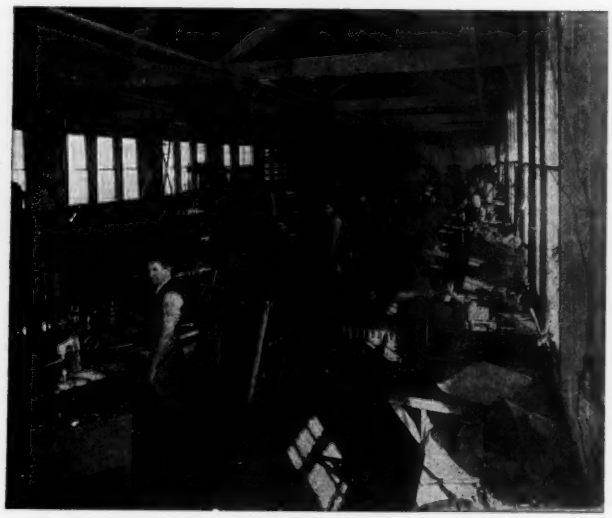
The New Plant of the Lagonda Manufacturing Company.

Twenty years ago, when water tube boilers first began to be introduced, a man named Weinland invented a machine for cleaning scale from out the tubes. It was of the type now known as the "turbine." When these cleaners were put on the market, the business was carried on in a 10-ft. by 12-ft. room, the cleaners being made outside. The venture proved successful, and the cleaners came into favor so rapidly that machinery for their manufacture was purchased and installed in a room 24-ft. by 24-ft. The company then began to take contracts to clean boilers. In that way the merits of the cleaners were demonstrated to possible customers. Again the quarters became too small. This time the plant was moved into a 28-ft. by 70-ft. two-story building (built by the present company).

As water tube boiler plants became larger, the scale problem assumed more importance and the time that a boiler had to be laid off for cleaning represented a heavy loss of revenue, so the Lagonda Manufacturing Company sought to devise some machine that would permit the application of greater power to the scale cutting device. The result was their Weinland Mechanical Boiler Tube Cleaner, which can be propelled by any power. from a 4-H. P. water motor to a 25-H. P. steam engine or electric motor, and which is used almost exclusively by the Lagonda Company in its boiler cleaning contract work.

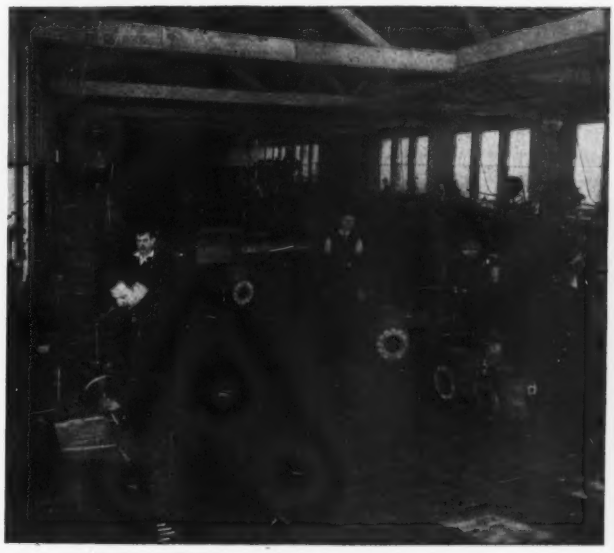


Turbine Cleaner Department, Lagonda Manufacturing Co.

The Lagonda Manufacturing Company has also added other specialties, and with the increasing demand for the Weinland cleaners has found greater manufacturing facilities necessary. A new plant has therefore just been built, consisting of a two-story 50-ft. by 200-ft. building, located on two acres of ground, which will be available for further growth.

The new building is a model in the character of its construction and equipment. The walls and floor are of artificial stone, and both floors are well heated, lighted and ventilated. It has modern wash-rooms, lockers and toilets. Every machine tool is driven by an individual motor, receiving power from a gas-engine driven generating plant. The absence of line shafts and belts and the large windows give plenty of light and make the shop an ideal place for workmen to do their best.

One illustration shows the interior of the turbine cleaner department, in which there are many expensive special machines. All the lathes and automatic machines are made with special attachments for turning out the peculiar bearings, water-wheels, arms and other small parts accurately and in great quantities.



Automatic Cut-Off Valve Department, Lagonda Mfg. Co.

The other illustration shows the cut-off valve department, which is devoted to the manufacture of a device placed in the steam connections of boilers for automatically stopping the passage of steam in either direction in case a steam main bursts or a boiler tube gives way. It works equally well in both directions and contains no pistons or other sliding parts which could stick or bind.

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Book Review.

"Locomotive Engine Breakdowns and How To Repair Them," by W. G. Wallace. Pocket Book size with flexible cover. 285 pages and 55 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $1.50.

The questions, with answers thereto, which are given in this book, are a collection of nearly 400 questions that were asked by enginemen during a number of years and answered by Mr. Wallace through the columns of *The Brotherhood of Locomotive Firemen's Magazine.*

The questions asked were the outcome of difficulties encountered in the daily work of practical men and cover a wide range of subjects. The back of the book is devoted to a number of useful tables and pointers. As each question and answer are numbered, the index enables the reader to turn to the question in which he is interested. This book should prove very useful to any one interested in locomotive engines.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Knowlton Packing Co. have moved from 14 L Street, South Boston, to their large new factory, in Chapel Street, Newton, Mass., where they will continue the manufacture of Knowlton packings, valves, washers and moulded goods, together with all the famous Lubron products and the Ellis lubricators. The address will be Knowlton Packing Co., Chapel Street, Newton, Mass. Telephone number, Newton, North 895.

Charles H. Glasser, formerly mechanical engineer of the Camel Co., Chicago, has accepted a position with the American Steam Gauge & Valve Mfg. Co., and will make his headquarters at their Chicago office. Mr. Glasser has had several years experience in the mechanical field and has a very wide acquaintance.

Economy Belt Dressing is an oil preparation that is said to be a splendid leather preservative and to greatly increase the pull of the belt. In order to introduce it the makers are giving coupons which are good for numerous valuable premiums. A booklet and full particulars will be mailed upon request. Address W. H. Kay & Co., 246 Fulton Street, New York City.

The Ideal Metallic Packing Co. have moved from St. Paul to South Stillwater, Minn.

Messrs. Adam Cook's Sons, 313 West Street, New York City, the only makers of "Albany Grease," are sending to the trade a new booklet dealing with their product and bearing the title "Machinery Lubrication." It is considerably more than a trade catalogue. It is full of live interesting information about lubrication of machinery. The booklet is of convenient size for the pocket or file, and is illustrated by pen and ink drawings, indicating various classes of machinery that use "Albany Grease' as a lubricant. This includes everything from an "automobile to a battleship." The cover of the booklet is attractive, bearing the slogan, lighten your machinery loads with "Albany Grease." It also shows the familiar "Albany Grease" trademark as a prominent feature in colors. You can have this booklet free by writing for it.

Brochure, No. 101, which is the advance agent for a fine large catalogue which they intend getting out on the Twin City Corliss engine, has just ben issued by the Minneapolis Steel and Machinery Co., Minneapolis, Minn. Brochure No. 101 contains 32 pages, 6 in. x 9 in., handsomely printed in colors on plate paper and illustrated with numerous half-tone illustrations of Twin City engines, both assembled and in parts. It also explains the construction and duties of the various parts and shows some complete installations. Those who are interested in or contemplate the purchase of a Corliss engine, should write for a copy.

A very instructive catalogue, which is just off press, is being distributed by the Hoppes Manufacturing Co., 70 Larch Street, Springfield, Ohio. It contains an interesting description of the Hoppes specialties, including live steam feed-water purifiers, standard steam feed-water heaters and purifiers, oil eliminators, steam separators and the new Hoppes cast-iron exhaust head. The catalog is of standard size, 6 in. x 9 in., the cover being embossed in old ivory design.

The latest improved 1907 Rochester Automatic Lubricator is described in the new catalogue, issued by Green, Tweed & Co., 109 Duane Street, New York. It describes in detail the construction and operation of the latest type of Rochester automatic lubricators and gives various applications of this device in connection with the forced system of pumping oil automatically. Forced feed lubrication possesses so many advantages of lubrication for steam and gas engines, air and ammonia compressors, steam pumps, plunger elevators and bearings, that every engineer should have this catalog.

A type of valve, which has for some time been in large demand, is known as the regrinding valve. This demand has been caused by the increasing tendency toward the use of higher steam pressures and more exacting duties of steam valves. A valve of this type, which has had extensive use, is known as the Williams Regrinding Valve, the constructive details of which is well illustrated and described in a small booklet issued by the D. T. Williams Valve Co., Cincinnati, Ohio. A copy will be sent to any engineer upon request.

The Marion System of Feed-Water Heating and Purification is very interestly described in a well-printed catalogue, issued by the Marion Incline Filter and Heater Co., Marion, Ohio. This heater contains a number of details of design which are quite different from the usual design of open feed-water heater, and the manufacturers would like to send their catalogue to anyone interested in feed-water heaters or separators.

Mr. Clifford P. Williams, formerly and for several years Supreme Chief of the American Order of Steam Engineers, has accepted a position with John R. Livezey, the expert in pipe covering and cold storage insulation. Mr. Williams was with Mr. Livezey some years ago, and his friends will be glad to know that he is back again where he can supply all their requirements in insulating materials for every purpose.

Kieley & Mueller, 34 West 13th Street, New York, have issued their new 1907 catalogue of original steam specialties, each of which is guaranteed by the firm to give perfect satisfaction. The new catalogue is attractively printed and illustrated throughout with good cuts of the various specialties manufactured by the firm, including, reducing valves for all purposes, back pressure valves for all purposes, atmospheric relief valves for all purposes, steam traps for all purposes, damper regulators, hot water temperature controllers, steam and water separators, oil and grease extractors, pump regulators, return steam traps, water feeders, boiler feeders, grease and oil traps, water arches, emergency valves, high and low water alarms, strainer connections of various kinds, drip tank controllers, pump governors and receivers, combination muffler and grease extractor tanks of various kinds, feed water heater and purifier, waste heat utilizers of various types that save coal, special apparatus of any kind in our line made up if possible to do so. A copy of the new catalogue will be mailed to any one interested.

The Western Branch is the Western Kieley Steam Specialty Co., 112 Lake Street, Chicago, where they carry a complete stock, so as to fill orders promptly.

In time of peace prepare for war. When the days are warm get ready for the cold. If you have not yet ordered an Economy Faucet, do it now, before the free trial offer expires. It enables you to get either hot or cold water from the same faucet. Address, Economy Faucet Co., 97 Weybosset Street, Providence, R. I.

100 Letter Heads, 100 Envelopes, and 100 Business Cards and Case, $1.50 postpaid Samples 2c. R. ELLIOT, Box 1376, St. Louis

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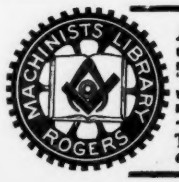

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SUPREME COURT DECIDES IN FAVOR OF CHAPLIN-FULTON MFG. CO.

In the action of R. G. McAuley against The Chaplin-Fulton Mfg. Co., of Pittsburgh, manufecturers of the Vigilant Feed Water Regulator, in which McAuley claimed that he was entitled to certain royalties, a decision has been handed down by the State Supreme Court in favor of The Chaplin-Fulton Mfg. Co., confirming the finding of the lower court, the case being dismissed at the cost of the plaintiff, McAuley.

The Trill Indicator Co., of Corry, Pa., is distributing a book about their indicators, reducing wheels and planimeters which contains much useful and handy information about taking and reading indicator cards. It shows in detail how to tap the cylinder, make pipe connections, place the indicator, connect it with the crosshead, adjust the tension, etc. The indicator diagram for a single cylinder engine is carefully analyzed and rules given for finding the horse power. Characteristic diagrams from engines of various types, including faulty diagrams, are analyzed and suggestions made for their correction. This book should be in the hands of every steam engineer.

The Stillman-Carmichael damper regulator is shown nicely in the fine catalogue issued by the Stillman-Carmichael Co., 19 Pearl Street, Boston, Mass.

The Sterling Senior and Sterling Junior Steam Trap are shown in two large half-tone illustrations in the catalogue of the Templeton Mfg. Co., 22 Randolph Street, Boston, Mass. Some of the advantages claimed for the Sterling Trap are as follows: Fully automatic under any pressure; floods or moderate condensation handled with equal facility; no steam waste, because of its gun-discharge, which leaves the valve either wide open or tight shut; discharge outlet same area as inlet, and no floats or packed joints.

Green Engineering Co., of Chicago, have moved to 1848 Commercial National Bank Building.

The Bangs Automatic Oil Cup provides a highly economical means of lubricating crossheads, crank pins, and other moving parts, and regulates the feed according to the speed of engine. It can be placed in any position on eccentrics, crossheads, crank pins, or any reciprocal bearing. When the engine stops, the flow of oil stops; and the more speed, the more oil is fed. Sediment, owing to the peculiar construction of the cup, cannot clog up the opening through which the oil passes to the bearing, and it can be filled, if desired, without stopping the engine. E. D. Bangs, of Milwaukee, who is widely known among engineers in the middle west, has perfected this cup after years of experience, and the Automatic Oil Cup Co., 155 Huron St., Milwaukee, Wis., would like to send every engineer a free copy of their catalog, which describes this cup in detail and shows both exterior and sectional illustrations.

Mr. W. B. Wilkinson, 7 Beekman St., New York, has been appointed sales agent for the high duty safety water boilers, manufactured by the Oil Well Supply Co. He will be glad to mail one of their handsome catalogs, showing both exterior and sectional views of their boilers and to quote prices to any one interested.

G. C. St. John, formerly located at 143 Liberty Street, has moved to 90 West Street, New York, in the magnificent new West Street Building.

Nathan Mfg. Co., of New York, have moved to new offices in the Singer Building, on Broadway.

The Patterson Lubricating Co., New England, agents for the Lagonda Mfg. Co., have opened new offices at 114 Broad Street, Boston, Mass., where they occupy the entire first floor with a large storehouse in the rear. There are two large show windows in front, one of which is entirely filled with Lagonda products, and which makes a handsome display. On Sunday, April 14th, they had an opening, at which some 300 engineers were present, and every one had a good time and a good luncheon.

The Garlock Packing Company have under way a fine new three-story fireproof office building at Palmyra, N. Y., for the accommodation of the head office forces, the general sales department and the purchasing department. The establishment of a new factory at New Orleans and the opening of several new branch stores now gives them a string of twenty-one branch stores and five factories.

The Ashton Valve Co. have completed plans for a large new factory in Cambridgeport, Mass. It is to be three-story brick or concrete, 200 x 50 feet, with capacity for four hundred workmen. Demsmore and Le Clare are the engineers.

One of the small things in a steam plant that probably gets less thought when things are going right and more thought at the time of an accident than any other feature of the entire plant, is the fusible plug in the boiler, and yet this little plug is the only real protection against accident from low water, and is therefore a highly important factor. The trouble in the past has been that so many make shift plugs of an inferior quality, have ben used that they have probably caused almost as many accidents as they have prevented. A new plug has just come to our notice which is a decided improvement over any that we have seen; in fact, it is just about ideal, giving perfect protection with which is combined great strength and easy accessibility. This plug is fully described and illustrated in a circular issued by Chas. T. Luce Co., 160 Congress Street, Boston, Mass.

Boston rebuilt incandescent lamps at 12 cents each, as advertised in this issue, are certainly worth a trial.

Mr. J. B. Hackett, 5 Beekman Street, New York, has issued a new circular illustrating his line of specialties, including steam traps, separators, oil fitters, damper and pressure regulators, reducing valves, metallic packing and New England Roller Grates. A copy of the circular will be mailed to any reader.

To provide adequate quarters for their rapidly increasing business, the Quaker City Rubber Company, of Philadelphia, have moved their offices to 629 Market Street, where with about double the floor space and greatly improved facilities, they are in a better position to meet the large demand for their famous P. P. P. Packing.

It is to the operating engineers' appreciation of the superior qualities of P. P. P. Packing that the Quaker City Rubber Company owes much of its growth, and ever mindful of this fact they will still further endeavor to give that satisfaction which has so strongly developed the business friendship between their house and the operating engineer.

SOCIETY NEWS

Lehigh Council No. 15, A. O. S. E., of Allentown, Pa., lost two members by death during the month of March: Martin H. Clewell and Horace Fogle. Mr. Clewell was a charter member, and prior to a long illness had always been an active and popular worker in the Council. Mr. Fogle lost his life while alone with his engine at the plant of the American Steel and Wire Works, on what is known as the Rod Mill engine. The exact nature of the accident is not known, but it is believed that he was caught while leaning over the guides oiling. Resolutions of respect and sympathy with the families of the deceased members were inscribed at the regular meeting of the Council on March 27th.

The Michigan N. A. S. E. State Convention will be held at Detroit July 19-20. The Light Guard Armory has been secured for an exhibit hall, where it is the intention to show a large exhibition of power plant equipment and engineers' supplies. Manufacturers wishing to engage space should write A. W. Miller, Secretary, 41 Greenwood Ave, Detroit.

The Annual Convention of the Supreme Council of the A. O. S. E. will be held at Atlantic City, June 10th to 13th. Headquarters will be in Casino on Steel Pier. Owing to the Car Builders' Convention being held in Atlantic City at the same time, a larger number of visitors are expected, so that those who intend going should make early reservation of their hotel accommodations. This can be done direct or through the committee. Among the features that have been arranged for the entertainment of the members and guests are a sailing trip, a trolley party and a smoker, which latter is expected to be very interesting. Full information may be had by addressing W. S. Price, Secretary, Haddon Hall.

Eureka Association No. 15, N. A. S. E., of Evansville, Ind., gave a delightful entertainment on Monday evening, May 6th, after which refreshments were served. The members and their friends were out in force.